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THE SNOWY TORRENTS:

Avalanche Accidents in the
United States 1967-71

Abstract

Williams, Knox.

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This compilation of 76 avalanche accident reports teaches by example, both good and bad. Commentaries will help those who spend time in the mountains in winter how to avoid getting caught in an avalanche, or if caught, how to survive.

Keywords: Avalanche, avalanche rescue.

About the cover: A soft-slab avalanche captured at the instant of release. Having triggered the slide, the skier is desperately trying to keep his balance and ski out to the side. Note the intricate pattern of cracks and the buckling of the slab as it fractures into large angular blocks. Photo by R. Ludwig.

**THE SNOWY TORRENTS:
Avalanche Accidents in the
United States 1967 - 71**

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“The snowy torrents are like the deep sea;
they seldom return their victims alive.”

From
Kampf über die Gletschern (Battle over the
Glaciers) by W. Schmidkunz

¹Central headquarters is maintained at Fort Collins, in cooperation with Colorado State University.

PREFACE

Each winter approximately 10,000 avalanches are observed in the mountains of the United States. Many times this number fall but go unobserved. It is an unfortunate but immutable fact that man, his structures, and his facilities will be involved in a small percentage of these avalanches. The result is often terror, death, and destruction. Statistics compiled in recent years in the United States (based on data provided by the U.S. Forest Service Westwide Avalanche Network) reveal that in an average winter 140 persons are caught by avalanches, 60 either partly or wholly buried, 12 injured, and 7 killed. Also, an average of 30 vehicles are buried with 10 of these sustaining damage. In addition, 10 buildings, 2 ski lifts, and 7 to 10 miscellaneous structures or facilities are damaged each winter. Annual property damage by avalanches is roughly \$250,000.

These statistics reveal the current magnitude of the avalanche problem in the United States. However, due to the rapid growth of winter recreation in this country, it is anticipated that these figures can only increase as time passes. The goal, therefore, is to keep the annual avalanche toll within a tolerable limit; the key to approaching this goal lies in public education. The range of this task begins with general avalanche awareness for the novice skier or snowmobiler and extends all the way to refining the skills of ski patrolmen and snow rangers. *The Snowy Torrents* is published as a partial fulfillment of this goal and is intended for an audience of skiers, climbers, snowmobilers, motorists, highway workers, cabin dwellers, mountain rescue teams, and a wide assortment of other interest groups.

This report is a compilation of 76 avalanche accidents that occurred in the United States from 1967 through 1971. It is a sequel to *The Snowy Torrents, Avalanche Accidents in the United States, 1910-1966* which was edited by Dale Gallagher and documents 63 accidents. The purpose of publishing these accidents is to teach by example—both good and bad. The experiences of many unfortunate avalanche victims can become lessons for us all.

Each accident report is concluded with a commentary. A strong effort has been made to treat the individuals involved in an accident—victims, survivors, rescuers—fairly. Wise and correct decisions and actions are praised; rash or unproductive actions are criticized with the intent of teaching the necessary safety procedures. Adverse criticism is aimed at pointing out lessons to be learned; obviously, there is no intent to embarrass any individual. The commentary section also serves to discuss some of the controversial subjects such as: avalanche zoning; “temperature release” avalanches; and hang-fire or post-control avalanche releases.

It is also interesting to note the categories within which the 76 accidents of this report are classified. Thirty-five accidents occurred within ski areas: of these, 18 involved ski patrolmen or snow rangers performing their duties; and 17 involved recreational skiers. Ski tourers were involved in 12 accidents; climbers and hikers, in 11 accidents. Also included are four snowmobile-avalanche accidents and seven accidents involving either motorists, highway workers, or other workmen. Finally, there are seven accidents which damaged houses, cabins, or buildings, bringing death to the occupants in several cases.

Each accident documented is identified by a number that indicates the year, and the sequential number of the accident within that year. For example, No. 67-4 designates the fourth documented accident for 1967. This is the same numbering system used in the original *The Snowy Torrents*, and occasional references to accidents in that volume are made here. Beneath the heading is a statement of the toll of the accident; that is, the number caught, buried, etc. These terms are defined in the Glossary, Appendix 1.

Photographs and drawings are included with as many accident reports as possible. In the drawings, an open circle is used to indicate the final position of persons who escaped the avalanche or who were only partly buried; a solid dot indicates the final position of buried victims.

It is hardly instructive to study incomplete or inaccurate accident reports; conse-

quently, only well-documented cases appear in this volume. Anyone involved in an avalanche accident is encouraged to provide thorough and accurate documentation if possible. Appendix 5 gives a sample of a complete information form for recording the details of an accident. Photos, maps, newspaper articles, and firsthand statements should be included whenever possible. A copy of the report should be sent to the Alpine Snow and Avalanche Research Project, Rocky Mountain Forest and Range Experiment Station, 240 W. Prospect St., Fort Collins, Colorado 80521.

These reports will be compiled into future volumes of *The Snowy Torrents*.

At the end of this volume are five appendixes which include a glossary (Appendix 1); an explanation of the avalanche classification (Appendix 2); recommendations for avoiding and, if caught, surviving avalanches—all based on the experiences of avalanche survivors (Appendix 3); survival statistics for completely buried victims (Appendix 4); and an accident reporting form (Appendix 5). The information contained here should provide valuable guidance to safety-conscious individuals and rescuers alike.

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*1 caught, buried, and injured***Weather Conditions**

One foot of new snow containing .95 inch of water fell overnight on January 4 and 5 at Jackson Hole Ski Area. As the storm moved in, winds were moderate west-southwest and temperatures were in the twenties.

Accident Summary

On the morning of January 5, three Jackson Hole ski patrolmen—Richard Porter, Bob Sealander, and Kent Hoopingarner—skied down from the top of Rendezvous Peak and threw hand charges along their control route. When about half way down the mountain they began working the side of a deep gully, now called Dick's Ditch. Several hand charges were thrown along the upper end of the gully. Then Sealander made a high ski-cut and released a small surface sluff; he then skied around a hogback and continued his ski-checking. Porter skied underneath Sealander's cut, stopped, and then started to ski down the fall line. After his second turn, the slope fractured about 30 feet above him. A first-person account of Porter's ordeal taken from *Western Skier* magazine reveals his thoughts at the moment of being caught and then buried.

"I looked uphill and saw the snow hurtling toward me. There was no chance to out-ski the slide; I was knocked down almost immediately. I dropped my poles and began 'swimming' with it in an effort to stay on top of the snow. I finally came to a stop lying on my side, twisted around so that my feet were higher than my head. As the snow from above buried me, I managed to move my head around enough to form a small air pocket.

"The avalanche ended as quickly as it had begun. I could hear the muffled crunch above as the snow settled around me. It was solid, like being in a bag of wet cement. I couldn't move at all, but I wasn't uncomfortable. Oddly enough, I felt no sensations of cold, pressure, or even fear. . . just a cozy feeling of being all covered up with a thick, soundproof quilt. Even though I concentrated on breathing

slowly to conserve the limited air supply, I soon lapsed into unconsciousness."

Rescue

Rescue began immediately. Hoopingarner climbed up to mark the last-seen point while Sealander skied to the base area. Within 11 minutes, a hasty search party of 15 men was organized and on the way up the tram. Arriving at the accident site, they searched likely locations at the area, finding no clues. A few minutes later the organized rescue party of 20 men arrived with packs, probe poles, and shovels. A probe line was established and worked up the slide area, not hitting anything. Hoopingarner thought the line had gone too far so they started back by his original mark. This time a probe pole hit a ski just a few feet from the last-seen point. Shovelling began.

After being buried 65 minutes, Richard Porter was pulled from beneath 5 feet of snow, gray, unconscious, and not breathing. Dr. Sam Southwick began mouth-to-mouth resuscitation immediately, then oxygen was applied. The victim began breathing again and was loaded into a snow cat and taken to the base area. To counteract the exposure he had suffered, he was stripped and placed in a tub of warm water. Later, in the hospital, intravenous fluids were given to counteract muscle cramps and blood poisoning resulting from oxygen starvation. Porter made a full recovery and was on skis again in 5 days.

Avalanche Data

The avalanche was classified as SS-AS-1: it was a small slide 120 feet wide and ran a mere 80 feet slope distance. It ran on an open slope having a south exposure and consisted of new snow sliding on an old snow crust. The slope was steep, nearly 40°, and ended in a deep gully; the debris from this small slide was extraordinarily deep.

Comments

When the control team entered Dick's Ditch, they had but one hand charge left, and it,

was being saved for another spot. In retrospect, that charge should have been used here. As an alternative, Porter should have continued his ski cut under Sealander's instead of stopping and then skiing down the slope.

Small slides are often the killers, and this avalanche very nearly proved fatal. The victim was swept to the bottom of the gully and buried deeply. Had he been buried many more minutes, he would not have survived. This incident provides evidence that, in a few cases, a buried victim has a better chance of survival with his skis on. The skis provide two more objects to be located by rescuers, and in this case, a ski was struck first by the probe pole. (However, the victim can swim with the slide more easily if skis and poles are cast off).

Richard Porter has these comments on his survival, again from *Western Skier* magazine:

"I had a lot of time to think about why I survived for an hour, while other avalanche victims die in minutes. Fast, efficient rescue is the prime factor, but what goes on under the snow is important too. Making that air pocket undoubtedly saved my life. I'm in good shape physically and don't smoke so my system utilized the available oxygen efficiently. Having skied professionally for almost 10 years, I've become acclimated to the high altitude and cold. As a patrolman, I was familiar with avalanches and survival techniques such as making air pockets and breathing slowly. The fact that my head was lower than my feet helped blood circulation to the brain, while lying on my side prevented me from choking.

"I was lucky. A slight variation in any of these conditions and I probably wouldn't be alive to tell the story."

1 caught, buried, and injured; 1 vehicle buried

Weather Conditions

About 2 feet of snow had fallen during the 4 days preceding the accident. Temperatures were in the range of -10°F.

Accident Summary

On January 6, a crew of men working for the Star Valley Lumber Company of Afton, Wyoming were clearing the Smiths Fork Road of drifts to bring logging equipment out of the woods. The Smiths Fork Road is on Commissary Ridge, approximately 30 miles south of Afton. The men were trying to get the equipment out prior to more bad weather which was on the way.

At 0730 one of the men, Alvin Linstrom, was operating a bulldozer clearing the road of snow. He was working under a known slide area, an open slope with an easterly exposure. While the rest of the crew left for breakfast, Linstrom continued to work. Upon returning to the site, the crew discovered the whole area had been overrun by an avalanche. There was no trace of Linstrom or his bulldozer.

Rescue

For unknown reasons, there was a very long delay in reporting this accident to local authorities: the Forest Service in Afton did not receive the report until 1500. A check with the lumber company revealed that it was planning no rescue operation of its own, so the Forest Supervisor's Office in Kemmerer, 100 miles to the south, was notified.

At 1730 the Forest Supervisor returned from Ogden and was notified of the accident. By this time, rescue plans were belatedly underway. The Search and Rescue Unit, headed by the Lincoln County Sheriff, was planning to send a six-man party from Kemmerer in via LaBarge Creek, east of the avalanche site, at 0400 the following morning. The sheriff did not want to send the party in until daylight because of possible avalanche hazard.

At 2315, Bernard Linstrom, the victim's brother, called the Forest Supervisor. He was in Kemmerer with seven men—including several relatives of the victim—and all were equipped with snowmobiles. He said the sheriff would not send anyone to lead them in

and none of them knew the country. He asked the Forest Supervisor if he would lead them to avoid further delay. The Supervisor agreed and left Kemmerer with this party at 0040 on January 7. Breaking trail in new snow and shoveling out a trail in one area slowed the progress of the rescuers; after almost 9 hours of travel they arrived at the accident site at 0930 on the 7th.

The Search and Rescue Unit left Kemmerer at 0500 and arrived at the scene at 1030. Their travel was much faster because the trail had been shoveled out and packed by the first party.

The initial rescue party was equipped with four 10-foot probe poles and immediately began probing the slide area at random. At 1000, Bernard Linstrom located the tractor by probing in a likely looking mound of snow. The top of the tractor was 5 feet beneath the snow surface. A few minutes later the victim, Alvin Linstrom, was found alive, still inside the canopy of the cat; he had been buried 26½ hours. Injuries sustained were a large bruise on the elbow, shock, and exposure. He was flown to the Afton hospital by helicopter and was released after examination.

Comments

Details on this accident are too few to draw any firm conclusions on the rescue efforts. It is not known whether a hasty search was conducted by the work crew shortly after the accident or whether the crew was equipped with a radio to send for help quickly. Even when the accident was finally reported in Afton, there was considerable confusion and delay in initiating rescue action. The helicopter used to evacuate the victim on January 7 might have been used on the 6th to get a rescue party to the accident scene while there was still daylight, weather permitting.

The considerable delay in getting rescuers to the scene nearly cost Linstrom his life. Fortunately the canopy on the bulldozer shielded him from much of the snow and provided an air pocket for breathing. However, even with adequate air, the victim may have succumbed to hypothermia had rescue been delayed much longer. Linstrom was indeed a very lucky man.

7 caught; 1 partly buried and 3 buried; 1 injured; 2 killed

Weather Conditions

On January 4, Arapahoe Basin Ski Area, 2 miles south of the summit of Loveland Pass, reported 10 inches of new snow and temperatures well-below zero on the night of the 4th. Thursday, January 5, was clear, cold, and windy. Snow began falling again on Friday the 6th but its depth could not be measured because of high winds. Northwest winds of 50 to 60 m.p.h. blew much of the day on Friday and the extreme cold continued. Slab conditions were forming on lee slopes, and high avalanche hazard existed throughout the weekend.

Accident Summary

On Saturday, January 7, Herb Kinsey, 32, took six boys from the Emily Griffith Home for Boys in Denver for a weekend winter camping and training trip. They were Dave Fritzler, 17; Don Porschatis, 17; George Davies, 17; Kenny Hunt, 15; Mike Anderson, 17; and Ken Landau, 17. Kinsey was the Administrative Assistant for the Colorado Outward Bound School and was an experienced mountaineer. He had taken boys out from the Emily Griffith Home before and was leading this trip on his own time during the weekend.

Because of the low temperatures, special care was taken to adequately equip everyone. Each youth was issued warm clothing, climbing gear, and sleeping essentials. Group equipment included tents, stoves, cooking gear, food, radios, and other climbing and survival gear.

At approximately 1115 they reached Loveland Basin Ski Area; the leader decided to proceed immediately to the summit of the pass on Highway 6 before returning that night to camp in the valley near the Loveland Basin Ski Area. The wind was moderate, and it was sunny but cold at the summit (-3°F at the Loveland top lift at noon).

After parking at the summit and assembling their gear, the group made their way to the crest of the ridge 30 to 40 feet above the pavement just off the road on the west side of the summit. It was necessary to kick steps

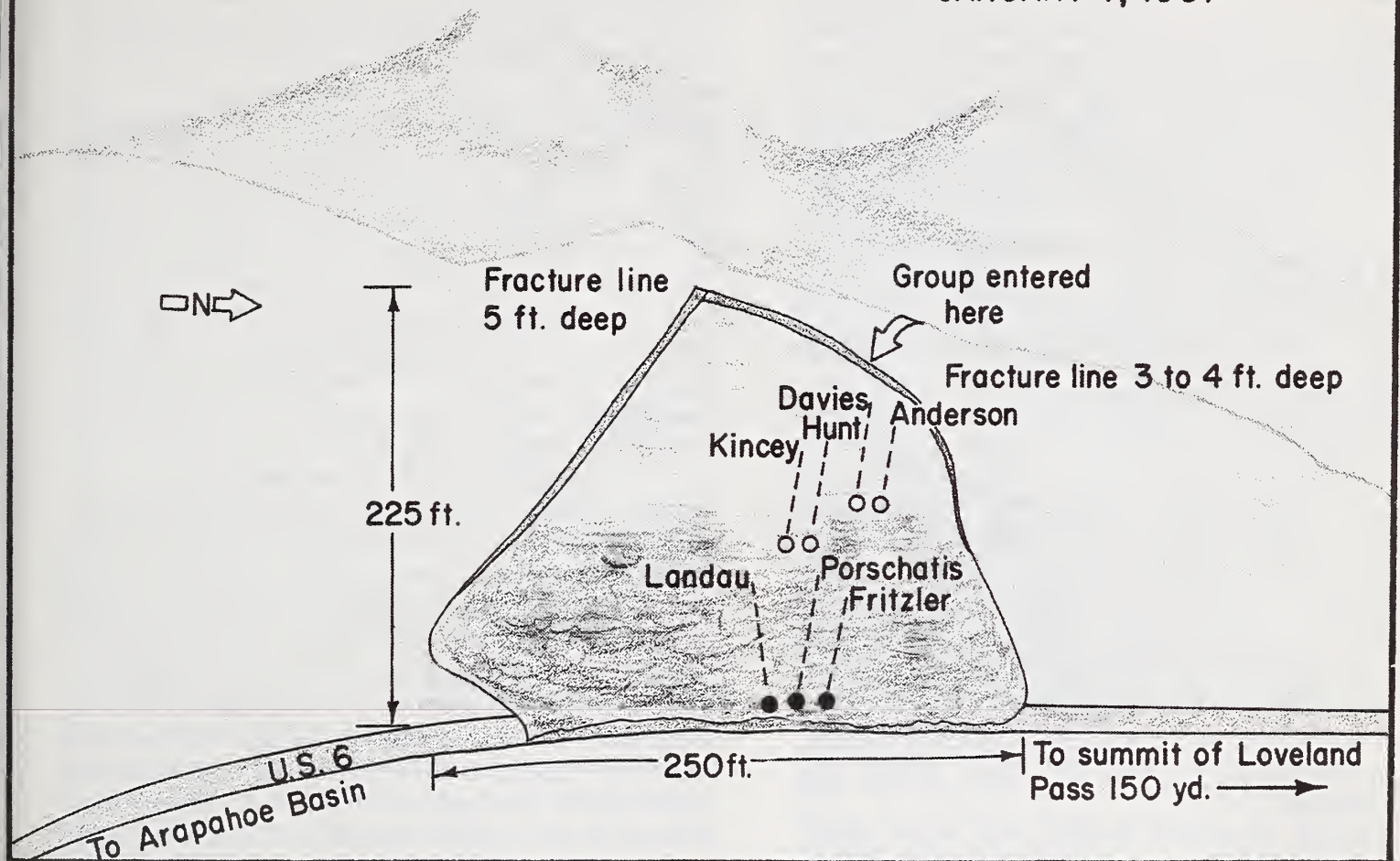
most of the way up, though in a couple of places they sank through the crust to soft snow about ankle deep. They continued along the crest, mostly on earth and rock, paralleling the road. Kinsey examined several areas along the crest that might be used for glissading (sliding in standing, squatting or sitting position) and finally picked one about 150 yards up the ridge (Arapahoe side) from the top of the pass.

Their vehicle and a highway maintenance truck were parked in plain sight. The time was almost noon. The slope had an average slope of 27°, but was considerably steeper at the top and flat at the bottom, with a slight rising lip at the edge of the road. The snow surface was firm enough for glissading and the slope well located; a good runout at the bottom made it impossible for anyone to slide out onto the pavement. The ridge crest at this point was 100 feet vertically above the road, 200 feet away measured horizontally, and about 225 feet along the fall line.

Kinsey stepped over the edge (there was no cornice) and tested the slope by glissading slowly down to about 30 feet below the crest, demonstrating basic glissading technique. The surface was firm enough to hold his weight without difficulty. The boys then spread out across the slope and began to glissade. Kinsey stood at his point of arrest about 30 feet down, instructing and supervising. The boys had been on the slope about 10 minutes, glissading down and walking back up. Some of them had made as many as three runs.

Suddenly they heard a muffled boom. Kinsey reported that he looked towards the highway to see if a vehicle had gone over the edge, but the sound was that of an avalanche releasing on the slope. The whole slope began sliding and all seven of the party were swept downhill. Because Anderson, Davies, Hunt, and Kinsey were near the top of the slope when the snow fractured, they managed to stay on top of the moving snow. Landau, Porschatis, and Fritzler, however, were on the flatter part of the slope near the bottom, and the snow engulfed all three. They were carried over the snowplow cut and onto the road and were completely buried as the snow

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 JANUARY 7, 1967



poured over their heads.

Individual experiences during the avalanche were recalled the next day when the surviving members reconstructed the scene. Anderson was near the top, about 10 feet from the point where they had come down onto the slope; Davies was slightly below him and to his right. (All directions given are facing downhill.) Anderson reported that the snow he was standing on gave way and he began to slide downhill. He remained in an upright position; then a wave of loose snow began to engulf him, reaching up to the hips. He began to kick and worked his way up through the snow and fell on his back, head uphill. He came to rest lying mostly on top of several blocks of snow; he had been carried about 40 feet down the slope. Davies reported that he went onto his hands and knees, facing uphill, and rode the slide on top of a slab of snow. At no time was he covered by loose snow. He was carried about 50 feet and came to rest on a relatively

flat area at the bottom of the slope, at least 100 feet from the road.

Kincey and Hunt were farther down than these two, and about 30 feet to their right. Kincey was instructing Hunt in the handling of his ice axe and in the proper sitting glissade position. Kincey was sitting and Hunt was standing beside him when the slide released. Hunt was knocked off his feet, and both he and Kincey were carried downhill riding on top of a slab of snow estimated to be about 18 feet square. Kincey shouted to Hunt to move uphill and swim if he was covered. Both attempted to crawl uphill on the slab. At no time were they buried in snow. They came to rest in the flatter area about 50 feet downhill.

None of these four persons, —Anderson, Davies, Hunt, and Kincey—were injured in the slide, and all took an effective part in the rescue.

The other three boys, Landau, Porschatis, and Fritzler, were standing at the bottom of

the slope, in the runout, where it was not steep enough to glissade. Landau had just done a sitting glissade diagonally down from the center of the slope to the right; he crossed below Kinsey and Hunt and came to rest in the flatter area of the slope. He stood up and was looking up at the others when the snow he was standing on began to heave up and down. Then he was hit by a wave of snow that knocked him down backwards, and he recalled sliding toward the road on his back, head downhill. Snow covered his face, and he felt he was choking with snow with every breath. Then he rolled over on his stomach, fought with his arms, trying to push up on the snow. He slid over the slight lip on the edge of the road and was dumped down onto the road. He soon felt a second impact, the weight of snow dumping down on top of him, pushing his face into the snow and pinning his arms beneath him. Landau recalled that he shouted three times for help, said a prayer, and passed out.

Porschatis and Fritzler had just completed their third slide, a sitting glissade in the track just below Anderson and Davies. They had come to a stop slightly below Landau. They were laughing and talking to each other. Apparently they were still in a sitting position, facing downhill toward the road, when the slide started.

Kinsey reported seeing two boys (they were all wearing orange parkas) lifted up by a wave of snow and carried toward the road. They disappeared as they fell onto the road and were covered with snow.

The whole slide probably lasted no more than five seconds. A triangular area 250 feet across at the base and 200 feet long (approximately 100 feet vertical) had come loose. Snow, 6 to 7 feet deep, covered the highway.

Rescue

When the slide stopped, three boys were safe—Anderson, Davies and Hunt—and three could not be seen—Landau, Fritzler, and Porschatis. The survivors heard three shouts for help and called back, but got no reply. Kinsey organized search operations immediately. He and the three boys probed in the snow with their ice axes for a couple of minutes in the approximate area of where shouts had been heard. Leaving the boys to continue probing, Kinsey then ran 150 yards uphill to the summit of Loveland Pass to seek help. The men in the highway maintenance truck parked there had seen the slide and had already radioed for help, requesting avalanche poles, a doctor, and a search party.

Cars were stopped on both sides of the slide, and skiers and passers-by began to gather at the slide scene. Kinsey asked some of those in the immediate area to recruit rescuers from the lines of cars; those equipped with ski poles and shovels began probing the avalanche debris. This began in a haphazard fashion. Kinsey then organized them into a line that moved from the road uphill through the slide area. Some continued to probe at random. The highway maintenance crew was among the first to join in the search. A state highway patrolman was there within 5 to 7 minutes. Within 10 minutes, 60 to 70 people had stopped and joined in the search; this group included Dr. John Bohannon (a Special Forces doctor from Ft. Bragg, N.C. who was a passenger on an eastbound bus) and an unidentified nurse.

It took 15 to 20 minutes to find the first victim, Dave Fritzler, under about 4 feet of snow. As soon as he was spotted, Kinsey told Davies and some spectators to get the litter, sleeping bags, clothing and first aid kit on the trailer at the top of the pass. Fritzler was not breathing and had a very weak pulse. Anderson, one of the survivors who had previous Outward Bound training, began immediate mouth-to-mouth resuscitation. Dr. Bohannon supervised the operation, giving directions. Moved to the road, Fritzler was laid on sleeping bags, covered with another, and given cardiac massage. Others rubbed his hands and feet. This was continued for about 45 minutes, under Dr. Bohannon's supervision, until Fritzler began breathing on his own. He was then given oxygen provided by an unidentified person.

Ken Landau was located next about 5 minutes after Fritzler was found. He was lying on his stomach, face in the snow, arms pinned below him. It was necessary to dig his arms out even after his body was uncovered. His feet pointed diagonally uphill. He likewise did not appear to be breathing when pulled from the snow. The nurse immediately began mouth-to-mouth resuscitation. Landau was moved to the road, placed on bags, and given cardiac massage. He began to breathe without assistance in about 20 minutes and was then given oxygen.

Don Porschatis was found last, about 5 minutes after Landau. He was lying face down, head uphill, feet toward the road. At this time (1230) the hasty search party from Loveland Basin Ski Patrol arrived and proceeded to dig him out. Even before he was totally uncovered, mouth-to-mouth resuscitation was

begun. Porschatis began to breathe on his own in about 20 minutes, and he too was then given oxygen. All three boys were found within 20 feet of each other in a line along the edge of the road just below the cut made by the snowplow. All were buried beneath about 4 feet of snow.

After the boys were extracted from the snow, Dr. Bohannan took charge and supervised their revival. Passers-by formed teams and applied mouth-to-mouth resuscitation, cardiac massage, and rubbing of hands and feet. At 1240 the main party of the Loveland Basin Ski Patrol rescue party and the Forest Service District Ranger arrived with additional emergency equipment and oxygen.

When the victims were breathing 14 times a minute, the doctor advised moving them. Since Landau appeared to be in the best shape, he was placed in an ambulance that had come up from the Arapahoe side and taken to the clinic in Dillon. The next day he was moved to Denver and returned to the Emily Griffith Home where he was then hospitalized for observation to avoid possible pneumonia. He soon made a full recovery.

The other two victims were in worse shape. After their breathing rate was up to 14 per minute, Dr. Bohannan advised moving them to the Loveland Basin Ski Patrol infirmary. They were transported in the ski area's station wagon and another car volunteered by a by-stander. There they were placed under the care of Dr. Fowler, the medical officer in charge.

Before leaving the scene of the slide, the ski patrol and Forest Service personnel insisted on checking names and numbers to ascertain that all persons were accounted for. Only when this was done, did they leave.

At Loveland Basin, Dr. Fowler placed Fritzler and Porschatis under resuscitators, one that he had and another that was brought up from the Idaho Springs Fire Department. They were later transported by two ambulances to St. Anthony's Hospital in Denver accompanied by pro patrolmen. The victims had difficulties on the trip in. One stopped breathing briefly and had to be revived with the resuscitator. Although the oxygen ran out on the other, he continued to breathe fairly normally. Both had convulsions during the trip, and neither regained consciousness. They were admitted to the emergency room at St. Anthony's Hospital and treated immediately; both were in critical condition and suffering from anoxia (effects of having been without oxygen).

Both boys suffered irreparable brain damage from anoxia; Porschatis died 4 days later, and Fritzler finally succumbed several months after the accident.

Avalanche Data

This avalanche was classified as HS-AO-2. In this case, the slide was triggered by the weight of the climbing party on the slope. The slope had sustained the weight of the climbers for several minutes before failure occurred. The hard slab had formed from the recent snow and strong winds; snow depth was 3 to 5 feet in the lee of the ridge but much of the windward side had been blown bare.

Fracture-line depth was 5 feet at the apex of the slide and 3 to 4 feet where the party was training. The slide ran only 100 feet vertically, but a large volume of snow was moved. The debris contained many large blocks of snow. Beneath the slab was several inches of depth hoar which had formed in the shallow snowpack earlier in the winter. Contributing to the danger of this slide path was the cut bank above the highway. The avalanche filled in this bank and resulted in all three victims being deeply buried.

Six of the Seven Sisters avalanche paths had run the day before, January 6. These had been shot down with artillery as part of the avalanche control on the Loveland Pass highway. Avalanche hazard was definitely high.

Comments

Kincey was a good leader and was experienced in climbing techniques and winter survival; however, he apparently did not consider the possibility of avalanches, or he misjudged the stability of the snowpack on this day. Two mistakes were made, one in planning and one in judgment.

First, a review of the preparations for the outing shows it to have been carefully planned except for one omission—no avalanche emergency equipment! They were properly clothed for winter weather and their equipment included suitable camping equipment, emergency gear, hard hats, first aid kit, 2-way radios, and a litter. However, had the boys been wearing avalanche cords, recovery of the buried victims might have been quicker. (Avalanche cords should not be trusted too highly; they also can end up completely buried.) Furthermore, no probe poles were included in the emergency gear. The omission of both these items suggested that an avalanche mishap had not been considered.

Second, an error in judgment was made by taking the group onto the slope without having checked on current avalanche conditions. Knowledge of the conditions was available at Loveland Basin and Arapahoe Basin ski areas. Both areas were concerned and had blasted slopes on Friday and Saturday. Avalanche danger was unusually high. Snow slides came down in Loveland Basin in places where they had never been seen before. Had Kinsey inquired about local conditions, he might have been warned and might have canceled the trip.

In addition, had he known the area better, he would have known that the chosen slope had a past avalanche history. However, the slope did appear safe, but deceptively so. It was not overly steep nor was it long. There was a flat runout at the bottom. The surface was tested and it was hard, but deeper probing with probe poles or ice axes would have revealed the weak, cohesionless layer. Further deception was added by the nearness of the

highway. It was felt the group was safe even in the event of mishap because their vehicle with all of their emergency equipment aboard was only 150 yards away.

Once the tragedy struck, emergency procedures were carried out well. Kinsey reacted excellently under stress and instantly assumed leadership of the rescue. He initiated a hasty search and within minutes had sent for help. Also he organized the passers-by into a search party that systematically probed for the victims. The medical care they got was outstanding, considering the conditions. The ski patrol and U.S. Forest Service personnel at both Loveland Basin and Arapahoe Basin showed a remarkable state of readiness.

Despite signs warning of avalanche dangers, this slope and the surrounding bowls continue to be popular ski-touring terrain, mainly because of the easy access. These circumstances virtually insure that more skiers or climbers will fall victims to avalanches in this area sooner or later.

11 caught; 5 partly buried and 3 buried; 2 injured

Weather Conditions

The weather on Sunday, January 15, was clear and reasonably warm for January in the Wasatch Mountains. The temperature in the Alta parking lot at 0930 was 24°F. Winds were gusting between 15 and 20 m.p.h.

Several days earlier, strong northwest winds had built up considerable wind slab at higher elevations. On Saturday, several avalanches were shot down at Alta, and several more were brought down at both Alta and Brighton on Sunday. The avalanches at Brighton, however, were much larger than those at Alta, signaling a higher instability in the Brighton area.

Accident Summary

A party of 13 skiers assembled at Alta on the morning of January 15 for a ski tour that would take them over Flagstaff Ridge and end at Silver Fork Lodge in Big Cottonwood Canyon. Before leaving, one member of the party called the Forest Service to check on avalanche conditions. He was told that the slab conditions created by recent west and northwest winds were still present. There was no widespread avalanche danger, but there was a very definite localized danger on high, lee slopes due to the heavy wind drifting during the last two days. He was also advised to stick to the ridges as much as possible and to avoid any deep drift pockets on lee slopes.

This was a group of well-experienced, well-equipped Wasatch Mountain Club members. All had experience in ski touring, but to different degrees. Two of the members had recently taken the National Ski Patrol Circle A Avalanche Course, and another member had received first aid training. The group's equipment included adequate clothing and food, climbing skins, avalanche cords, six avalanche probes, six first aid kits, and an Austrian portable toboggan.

The group climbed to the ridge, reaching it just west of Flagstaff Peak. Avalanche cords were used on the steeper slopes, but snow conditions appeared to be stable along the route that was followed. Party members

were advised to maintain a reasonable separation during the climb.

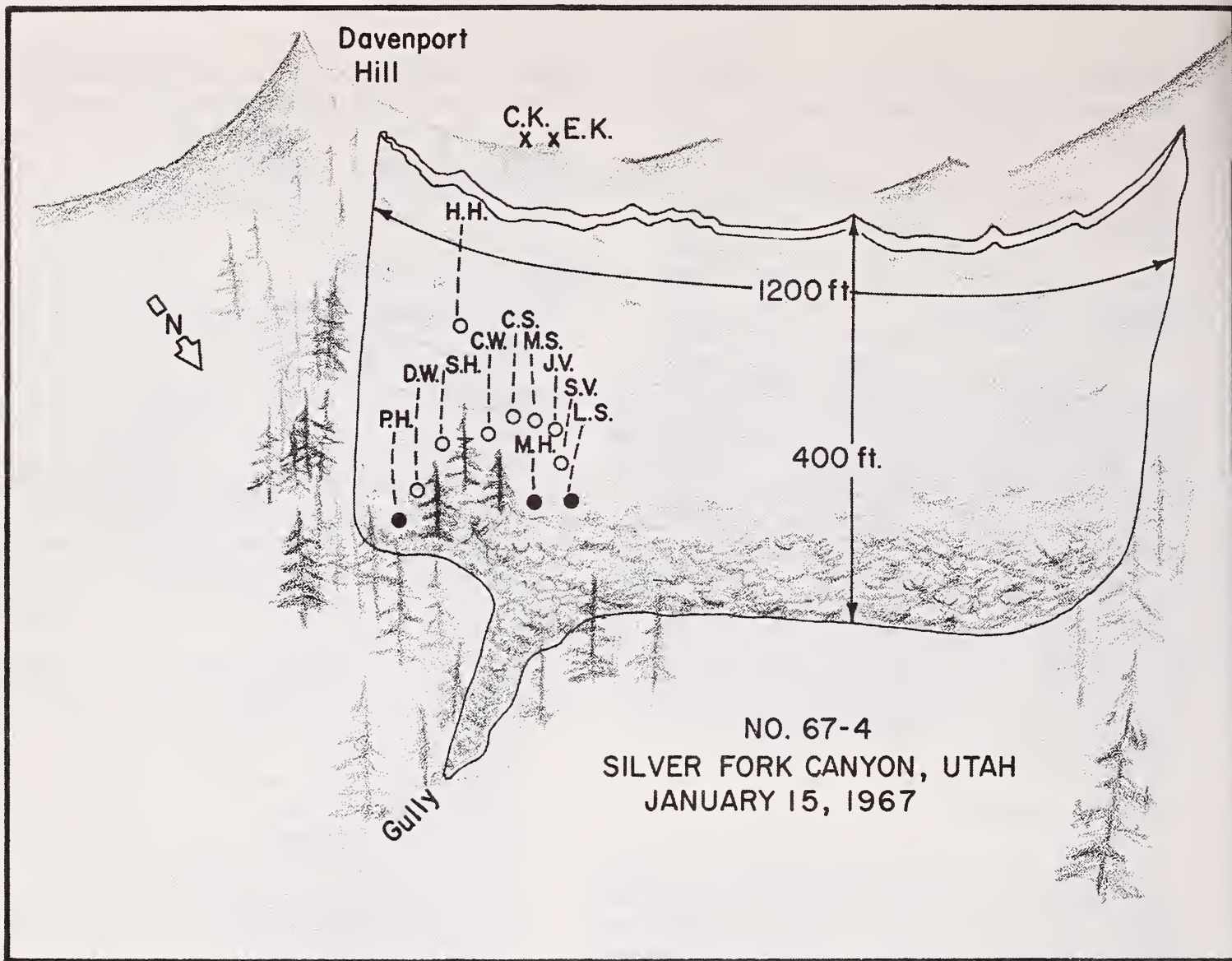
Once on the ridge the group traveled toward the east. Snow conditions varied from loose and reasonably light in wooded areas to extremely hard crust in the open areas. Except when traversing around Flagstaff Peak and around another minor peak about a half mile farther east, the group remained on the ridge. At the lowest point on the ridge above the head of Silver Fork, the group stopped for lunch.

The Silver Fork slope directly below the point where the group ate lunch faces a northeasterly direction. This slope, as well as those to the left (west) were devoid of trees. However, to the right (east) were several clusters of fairly large trees. To gain the protection of this vegetation, and to get farther away from the lee slopes of the recent winds, it was suggested that skiers who preferred not to ski down the fall line take a traverse to the right (east) toward the trees. The time was 1430.

Two of the first three skiers to leave the ridge, Milton Hollander and Lee Steortz, skied straight down; the third, Peter Hovingh, went to the right a short distance and then straight down. Several others left the ridge and headed to the right. Then, as if the enthusiasm to ski suddenly struck the group, all but two, Charles Keller and Ernest Katten, of the remaining skiers left the ridge. One turned to the left (west) and four others followed. They had proceeded 40 to 50 yards and were skiing very close together when the shot-like sound of the fracture was heard. The snow on the slope immediately broke into large slabs and began to slide. Of the two remaining on the ridge, only one, Keller, was able to witness the entire slide. It was impossible for one person to keep track of 11 people below. When the snow stopped sliding, the location of more than three or four of them was very uncertain. The five who had skied to the left (west) remained standing during most of the slide, but when three of them finally fell, they were lost from view.

Rescue

Because the fracture was just several feet



below the very small cornice on the ridge, it was not felt that further slide danger existed from above. Thus, as soon as the snow stopped sliding, the two men remaining on the ridge (Keller and Katten) started down, looking for people or equipment on the way. About 100 feet down the slope one ski was found; its owner, Hermann Haertel, was found clinging to a tree about 20 feet below. He was in considerable pain and claimed his right leg was broken. His left ski, still secured to his boot, was removed and, together with both skis belonging to Keller, was placed in the snow below him so he could relax without rolling down the slope. He was left there while the search for survivors continued. Keller went down to the point where several people were digging for Hollander who had been completely buried except for one hand, while Katten went to assist another group.

When the snow stopped sliding, a group of seven skiers—Hollander, Steortz, Steve and

June Viavant, Carl Schwenk, Max Townsend, and Carol Wiens—were bunched together. Steve Viavant, who found himself on top of the snow, saw a hand. He started to dig and found Hollander. Hollander immediately asked if anyone else was buried. Viavant looked around and saw another hand nearby. He dug there and found Steortz. June Viavant had also remained on top of the snow. She helped Schwenk, Townsend, and Wiens who were all buried to depths ranging from knee to waist deep. Keller arrived about the time Steortz's head was uncovered and helped dig Hollander out. As soon as he was free Hollander helped dig out Steortz, while Keller headed for another group, counting heads on the way.

Once the snow had stopped sliding, Hovingh, Delbert Wiens, and Suzanne Haertel had been thrown together. Wiens found himself free on top of the snow. Haertel was buried to her waist to the west of Wiens. Hovingh was completely buried, but when he

opened his eyes he saw light. He shouted for help. Wiens, who was almost overhead, heard him and started digging. Katten arrived on the scene from the ridge and helped Suzanne Haertel out of the snow, and then helped Wiens dig for Hovingh. Keller, who was counting people, found all accounted for and helped dig Hovingh free.

By the time all people were out of the snow, it was determined that one man (Hermann Haertel) had a broken or badly injured leg, another (Steortz) had a sprained ankle, and three (Hollander, Hovingh, and Steortz) had lost one ski each. Knowing that additional help could be used to take the injured man out and that the three men with single skis could probably use help, three people (Katten, Delbert, and Carol Wiens) were sent down to advise the sheriff and ask for aid. They left about fifteen minutes after the avalanche, about 1445. They arrived at Solitude Ski Area at 1630 and reported the accident to the ski patrol who, in turn, notified the U.S. Forest Service.

While the three men who had been buried probed for their lost skis (they did not find them), the rest of the party climbed back up the avalanche slope to the injured man. He was suffering intense pain, so much so that it was doubtful that he could be moved while in that condition. He was given a Percodan capsule, a pain relieving drug that was carried for just such an emergency. His skis and poles were used to assemble the emergency toboggan. By the time it was ready, the capsule had taken effect, and his spirits and morale had improved considerably. All excess clothing—mostly sweaters—were used to wrap his injured leg, and it was lashed to his good leg with climbing skins and secured by straps. He was then placed in the toboggan and the cover laced over him. In this position, his injured leg was completely immobile. He was taken from the avalanche slope by four men. At the bottom, they tied four ropes to the toboggan and the long trip down to the Solitude Ski Area began. The time was approximately 1520.

At this time two of the men who had been buried, and who had only one ski each (Hollander and Steortz), were sent ahead so that they could move down Silver Fork at their own pace and attempt to get to the highway before sundown. They arrived at the Solitude Ski Area at 1845.

All party members were at Solitude by about 2130 after a difficult trip. After the injured man reached the hospital and X-rays were taken, it was found that he had no broken bones. Several torn ligaments were repaired

in a subsequent operation, but he was still left with a badly damaged nerve in the leg. The latter accounted for his intense pain on the avalanche slope.

Avalanche Data

The slope on which the avalanche occurred was open and steep (about 37°) and had a northeasterly exposure. The avalanche was classified as SS-AS-4. The entire slope avalanched, being some 1200 feet wide and running a vertical distance of about 400 feet. The 11 skiers who had triggered the slide and who were caught were concentrated in the eastern one-third of the slope.

When the slope failed, there was the loud shot-like report and then the slab shattered into large pieces, some large enough that three skiers remained on top of the snow. The fracture line varied from 4 inches deep to more than 1 foot. Although much loose, light snow was involved, there was no dust cloud, allowing Keller on the ridge above to follow visually many of the skiers as they were trapped. The three men who were completely buried were well below the fracture line when the slide began; the five others that were partly buried were nearer the fracture line.

Comments

In all, 11 skiers were caught in the Silver Fork avalanche; 8 were buried, and 2 injured. Fortunately for the three completely buried victims, they were very near the surface; two had one hand showing and the cries for help of the third were quickly answered.

The snow and avalanche conditions reported to the group by the Forest Service that morning proved to be quite accurate. The Silver Fork slope was on the lee side of the ridge and was an area of localized danger because of wind slab. Shooting reports from Alta and Brighton that came in after the group had left revealed, however, that the avalanche danger was greater than had been suspected, especially near Brighton.

It can be concluded that two factors were primarily responsible for the avalanche. First, the number of people on the slope at one time was excessive; second, the suggestion that several of the skiers ski to the right (east) to gain the protection of the trees was not heeded. The fact the avalanche extended

about 50 yards to the east and 300 yards to the west of the entry point on the ridge, and the decrease in slab thickness toward the east,

suggests that had everyone gone toward the right (east), the avalanche might never have been triggered.

*3 caught and partly buried; 1 injured***Weather Conditions**

The early part of the winter of 1966-67 at Alta, Utah was characterized by large storms followed by periods of clear weather. In mid-October, a snowstorm dropped 21 inches of snow in the area. A clear period followed and the snow melted off the southern exposures, but patches remained on north-facing slopes. In mid-November another storm left 2 feet of snow on the ground for the winter. The November storm was followed by several days of cold, clear weather, and a tendency toward depth-hoar formation was noted on north-facing slopes. The snowpack gradually built up until mid-December, at which time there was a period of warm, clear weather.

During January 1967 an unusually large amount of snowfall was dropped by the storms that came in rapid succession with only brief breaks separating them. Throughout the month there were only 8 days when no precipitation was measured. One of these interludes occurred on January 18. On the afternoon of the 19th, the winds began to gust up to 30 m.p.h. from the southwest, and clouds filled the sky. It became apparent that a major storm was coming.

Little snow fell on the 19th and the 20th, but the winds continued blowing strongly from the southwest. On January 21, snow began to fall in earnest, and the wind gained intensity. The winds became so strong that day that the Germania chairlift was closed. It was noticed that north- and east-facing slopes were becoming loaded with drifting snow. The temperature was steady at 20° to 25°F throughout the day.

Accident Summary

During the period from January 18 to 28, the U.S. Forest Service was conducting its biannual avalanche school at Alta for Forest Service personnel. The field session for the afternoon of the 21st involved snow-profile studies on the mountain. The original plan was to dig snow pits to check the stratigraphy up high on the mountain in the release zones of some of the larger slides in the area. However,

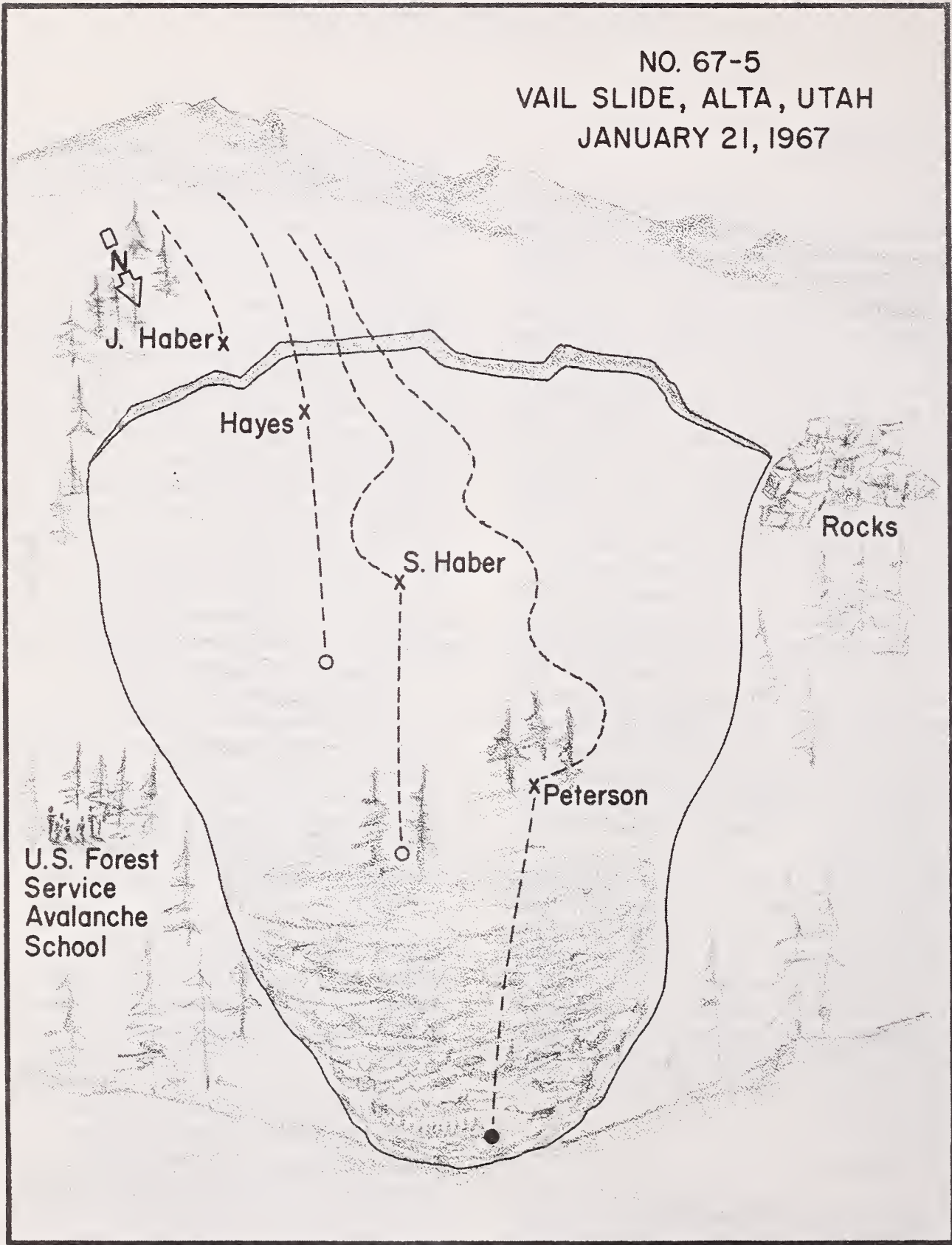
the closing of the Germania lift caused a change in plans. It was decided to carry out the field work on the ridge below the Albion gun tower, just west of the top of the Albion ski lift.

Leader Ed LaChapelle took the avalanche trainees to an area off the ridge and just east of a short slide path. There they dug a snow pit that revealed 21 inches of wind-deposited new snow overlaying slightly decomposed fine-grained old snow. Below the fairly solid old snow was a weak layer in which equi-temperature metamorphism had taken place. Underlying this layer was 6 inches of weak depth hoar capped by an ice crust. The depth hoar was probably formed after the early October storm, and the ice layer formed during the period of warm weather prior to the November storm. The layer of equi-temperature metamorphism crystals (ET crystals, for short) reflected the clear period following the November storm.

Snow Ranger Ron Perla was in the snow pit explaining the stratigraphy to the trainees. When he found the depth hoar, he decided that conditions were highly unstable. He asked the more experienced LaChapelle for his opinion, and LaChapelle said that he agreed strongly with Perla's diagnosis. The avalanche occurred almost immediately after these comments.

Meanwhile, shortly after 1500, four skiers— Bill Peterson, Steve Haber, Robin Hayes, and Janie Haber—departed from the Albion lift and headed out Never-Sweat Ridge in search of untracked powder. The four were expert skiers, the two men being ski instructors from Vail, Colorado. The closing of the Germania lift had eliminated some of the better powder snow runs; therefore the four decided to look for a challenge off the Albion lift, basically a beginner and easy intermediate area. The party skied out the ridge to a point just west of the route the Forest Service personnel had taken. Upon reaching the top of the short, steep slide path off Never-Sweat Ridge (now named the Vail Slide) they stopped momentarily; then Peterson skied about half-way down the slope, stopping next to some small trees. At this point, members of the avalanche school heard him calling out to the

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others in the party, telling them to ski on down. This was the first that the avalanche school knew of the group's presence on the slope. Steve Haber and Hayes immediately started down the slope, Haber in the lead. As he was making a hard jump turn to the right about one-quarter of the way down, the snow fractured above him; this carried him, Hayes, and Peterson down the hill. The fracture line was about 150 feet above Peterson, 35 feet above Haber and 15 feet above Hayes at the moment of release. As the three people were being carried down the hill, LaChapelle directed the avalanche school trainees to follow them with their eyes. One skier was seen to enter a small clump of trees and moments later emerge down the slope. The descent of Hayes was easily followed because she stayed on the surface.

Rescue

As soon as the slide came to rest, the Forest Service personnel marked the last-seen points and began a hasty search of likely areas. One of the trainees immediately went up the hill to a point about 90 feet below the fracture line, where Hayes had come to rest. She was found to be unharmed, though hysterical.

When the avalanche broke, Perla was still in the snow pit. He jumped out immediately, mainly for fear that he would be buried in the pit and only secondarily to aid in the rescue. Nonetheless, he ran toward the moving avalanche, following the path of Peterson who was being carried down the slope. Hence, Peterson was located almost immediately near the toe of the slide by a protruding ski tip. He had come to rest on his back, face up, head downhill, and had managed to clear the snow from around his face as he came to a stop. His legs were buried under about 3 feet of snow; and his head was about 18 inches below the normal snow surface but not covered because of its position between two blocks of snow. His arms were pinned down by his ski poles which were still on his wrists, but he was uninjured and calm when found.

Minutes later groans were heard near one of the small trees about two-thirds of the way from the top of the slope; here, Steve Haber was located. He was found with his head downhill, lying mostly on his side. While being carried along in the slide, he was forced against a tree, with his right ski passing on one side of the tree trunk and his body on the other. The force of the snow had thus put a great amount of force on his right leg. Although he

was wearing safety bindings, they were over-tightened and did not release; his right leg was badly broken at boot-top level and was somewhat displaced, causing him severe pain. His legs were under about 40 inches of snow; his head was about 18 inches deep but free of snow because of protection by tree branches.

As Haber was being dug out of the debris, the Forest Service personnel were informed by one of the victims that there were four people to account for in the slide, and probing was immediately resumed for the remaining victim. At this moment Janie Haber appeared at the top of the slope, safe and unharmed. When she had seen the slide release about 5 feet below her, she immediately jumped back to a tree at the top of the slope and had remained hidden there while the other victims were being accounted for. She was very calm, although she later began to show some signs of shock.

As soon as the avalanche occurred, two men were dispatched by LaChapelle to pick up probe poles and a toboggan from the top of the Albion lift. After all victims were accounted for, another man was dispatched to inform the lift operator that no probes were needed. Steve Haber had been dug free and his leg splinted by the time the toboggan arrived. He was evacuated to the ski patrol first aid room at the base of the Wildcat lift pending the arrival of an ambulance from Salt Lake City. At 1620, the ambulance arrived and he was transported to a hospital in Salt Lake City. All rescue operations were secured at 1630.

Avalanche Data

The slide occurred on Never-Sweat Ridge, a fairly short northeast-facing slope and a known slide area. The slope has now been named the Vail Slide in dubious honor of the Vail ski instructors who became the victims. At the release zone, the slope angle is 41°; it flattens to 22° at a transition zone below. The avalanche was classified as SS-AS-3, was 40 yards wide, and ran 120 yards slope distance. The zigzag fracture line was 8 inches deep on the east end and 30 inches deep on the west. The sliding surface was discovered to be an ice layer with a layer of weak ET crystals above and depth hoar below.

Comments

This is the type of accident that is difficult to prevent. With a storm in progress, avalanche hazard was increasing as the day wore

on. Dangerous areas were being closed as the intensity of the storm increased, but no closures were in effect along Never-Sweat Ridge.

Because of the strong southwest winds, a condition of instability arose in just a few hours; the Vail Slide should have been either

closed or checked for safety. This slope is now ski checked and hand charged during and after storms. However, ski checking is pushing one's luck on this slope; it deserves hand charges.

*2 caught, 1 buried***Weather Conditions**

A very cold fall with light snowfall and a thin snow cover caused the early season formation of depth hoar in the higher Wasatch Mountain areas. December 1966 brought normal snowfall plus two rain storms which produced hard sliding surfaces in the snowpack. Above-normal snowfall was recorded in January 1967, along with exceptional wind action.

Early February in the Alta and Brighton area found the weather generally clear and mild. Snow depth at Alta measured 105 inches. On February 10, a storm moved in and deposited 6 inches of new snow, most of it falling as graupel. Strong northwest winds gusting to 40 and 50 m.p.h. accompanied the storm.

February 11 broke clear and mild with moderate northwest winds. Afternoon cloudiness brought a trace of snow. Temperatures ranged from 12° to 26°F.

Accident Summary

At noon on February 11, two experienced skiers, Jack Gordon and Rex Anderson, left the Brighton Ski Area to ski tour Twin Lakes Pass to the west. They got off the top of Mt. Millicent lift and skied outside the ski area boundary without notifying anyone or inquiring about snow conditions. The selected route exposed them to extreme avalanche danger the entire way. They did remove their pole straps from their wrists, but their arlberg straps were left tied down on their skis.

Snow Ranger Will Bassett was standing on the ridge overlooking the Twin Lakes Pass area and the Brighton Ski Bowl when he observed the two men traversing across the hazardous avalanche area. Remarkably, he then observed the avalanche as it was released by the two skiers; the time was 1315. The snow fractured 80 yards above the men, and they were quickly engulfed by the slide.

Gordon was carried 200 yards downhill by the slide and buried just below the surface with his face up and head downhill. He was able to get an arm free and clear his face.

Anderson was carried approximately 120 yards in the slide and remained on the surface.

Rescue

When the slide stopped, Anderson discovered that he had lost one ski and one pole. Nevertheless, he started downhill looking for Gordon and found him buried but unhurt. Anderson was able to dig out his companion.

Not knowing that the skiers were unhurt, Snow Ranger Bassett reported the accident to the Brighton Ski Patrol at 1320. He then took three patrolmen and immediately headed for the accident scene. Seven minutes later a second hasty party of five patrolmen left with probes, marking flags, and a shovel. Several minutes later, the main rescue party of 10 men left for the scene, fully equipped.

At 1340, the first hasty party led by Bassett was in voice contact with the two victims and was assured that everything was all right. Anderson's missing ski was found, and they were able to ski out. The second hasty search party was stopped 300 yards from the accident site to prevent them further exposure to avalanche hazard. The main party was stopped ½ mile from the site. The back-up rescue party was then disbanded, and the ambulance that had been called was canceled. By 1430, the rescue effort had been completed and secured.

Avalanche Data

The avalanche occurred about 1½ miles west of the top terminal of the Mt. Millicent chairlift at Brighton. The slope has a northeast exposure and an average steepness of 30°. It has a history of sliding after most new snowfalls.

On February 11, the day of the accident, an identical exposure in the ski area was checked by artillery fire at 0800. It did not slide. However, estimates of avalanche danger were that the hazard was increasing during the day. Touring was closed on the 11th.

The avalanche was a SS-AS-3, approxi-

mately 100 yards wide and running about 300 yards slope distance (450 feet vertical). The fracture line was 2 feet deep for most of the width of the slide.

Comments

The accident reports do not state whether the two victims had crossed under any closure ropes or passed any closure signs. However, the area was closed to touring. The victims neither checked on avalanche conditions nor

notified anyone of their plans. Had they done so, they would have learned of the hazardous conditions and of the closure.

Had Gordon been buried deeper or had he not been able to clear his face so quickly, this avalanche may have taken his life. The good fortune of the snow ranger being an eyewitness to the accident made for a quick rescue, had it been needed. Failure to check weather and snow conditions and failure to observe closures are two sure ways of risking one's life in avalanche terrain.

2 caught; 1 partly buried and 1 buried; 2 killed

Weather Conditions

The Pharoahs Glen area is only a few air miles from the Twin Lakes Pass area of Utah. The same storm described in No. 67-6 also struck the Pharoahs Glen area, depositing dense graupel pellets and buffeting the hillside with very strong, gusty winds. On Saturday, February 11, the winds recorded at the Salt Lake City Airport averaged 37 m.p.h. The prevailing direction was northwest. Winds diminished on Sunday but were still gusty.

Accident Summary

At 0530 on Sunday morning, February 12, three boys left the Eastwood Grade School on Wasatch Blvd. on the east side of Salt Lake City. They were Dick Bills, age 15, his brother Tom Bills, age 14, and Bill Dubbeld, age 12. Their destination was Grandeur Peak, about 2 miles to the east and located between Mill Creek Canyon and Parley's Canyon, through which runs U.S. Highway 40. All three boys had considerable hiking experience in this area but no formal mountaineering experience.

Just before 1100, they reached the summit of Grandeur Peak and built a fire. After eating, they started down, jumping and playing on the north side of the peak at the head of Pharoahs Glen. Dubbeld dropped his canteen which rolled down the slope, and he slid down after it. After retrieving his canteen he had difficulty climbing back up the slope. He finally called to his friends that he wanted to walk on down and come out the bottom of the canyon. The other two boys consented and started down the slope. The time was about 1130.

Dubbeld had gone about 50 feet down the hill; Tom Bills was above him and Dick Bills was another 50 feet farther below him. Suddenly Tom Bills shouted "Avalanche!" But Dubbeld was engulfed just as he turned to look uphill. He was swept downhill and into a large pine tree, holding tightly onto a branch until the snow stopped moving. When the slide was over, Dubbeld found himself buried to the

waist and still clinging to the tree. He was able to dig himself out while Tom, who had remained above the slide, worked his way down the slope. There was no sign of Dick.

After a quick search of the area, Dubbeld left the slide site and headed down a northwest ridge to U.S. 40, several miles away. Tom Bills remained at the scene searching for his brother.

Rescue

At about 1330, Dubbeld reached the highway and flagged down a motorist. A few minutes later, the accident was reported to the State Highway Patrol and the County Sheriff. The Sheriff's office in turn notified the Brighton and Alta ski areas. Ski partolmen and Forest Service personnel began heading for the Eastwood School, where a base for the rescue operation was established. A helicopter was called to transport the rescuers to the slide scene.

The first rescuers were flown to the scene at 1525. The helicopter continued to take rescuers in by two's until there were 42 at the site. Probes, shovels, and other supplies were flown in with the rescuers. Because of the size of the rescue party, there was considerable confusion in coordinating the rescue effort. In addition, the rescuers did not know how many victims they were searching for or where to search for them. The sole eyewitness, Dubbeld, was flown in the helicopter over the slide area to determine the places where he had last seen his companions. By this time, Tom Bills who had remained at the accident scene, could not be found. Because Dubbeld was not closely interrogated by the rescue party leader, the rescuers did not know whether there were one or two buried victims or whether Tom had also walked away from the scene.

The rescuers began by probing deep deposition areas and by setting up a coarse probe line at the toe of the debris. Footprints were seen going down Pharoahs Glen below the toe of the slide. Some of the rescuers thought these tracks should be followed, but the decision was made to continue probing.

The coarse probe revealed nothing, so a fine probe was begun at about 1900. The probe line had moved about 200 feet up from the toe of the debris when the body of Dick Bills was found approximately 6 feet under the snow; he was lying in a prone position, head downhill. The boy's scout pack was on top of his head with both straps still on his shoulders.

The entire body was encased in an ice mask, a little heavier thickness around the face, but the opinion of the rescue group was that the boy was unconscious when he came to a stop. It was apparent he was bleeding slightly from either the nose or mouth, or both.

The snow was removed from around the body with fire shovels. The snow was too hard for the aluminum snow shovels to penetrate to any degree. Approximate evaluation of survival time was no longer than 30 minutes. The victim's right arm could be straightened out, but the left arm could not—it remained in a bent position.

While the probe line was searching for this buried victim, a report was issued over the radio that the other missing boy, Tom Bills, had been found safe on the ridge. This report was false, and no explanation for the error could be found. Fortunately, this report did not reach several of the rescuers who had become curious about the footprints leading down Pharoahs Glen. Six men began following the footprints. About $\frac{3}{4}$ of a mile below the toe of the slide debris, a hat and then a pair of socks belonging to Tom were found. Sixty feet from where the hat was found, Tom was found lying on his back in the snow. The time was about 2100. He was not breathing, and there was no heartbeat. Mouth-to-mouth resuscitation was given but to no avail. Tom Bills had died a victim of shock and hypothermia.

The bodies of both victims were flown out by helicopter at about 2300. Rescue operations were ceased at this time, and the main rescue party began walking out via Pharoahs Glen to U.S. 40. The last rescuer was checked in at the base camp at 0315 on Monday morning, February 13.

Avalanche Data

The slide was a soft-slab avalanche starting at an elevation of 8100 feet and running to 6500 feet, a vertical drop of 1600 feet. The width was 300 feet at the starting zone and 150 to 200 feet in the runout gully. The fracture line was only 4 inches —4 inches of soft slab

that had been deposited on a one-inch-thick layer of graupel. It slid approximately 150 yards on this surface and then started to break away underneath. At about 200 yards, it dug right down to the ground level. A snow pit showed 8 inches of depth hoar right at the ground. In addition, the ground cover consisted of long grass bent downhill. The combination of the hoar and the grass provided a slick running surface.

The slope was on a north exposure and had a steepness in the starting zone of 33°. There was a 5-foot snow cover in the starting zone and track. Rescuers found a lot of evidence of avalanches in past years: shrubbery and trees were very sparse, and those in the slide path were markedly scarred up.

Comments

The rescuers erred by not questioning the survivor more closely and by not putting him back on the ground at the slide scene. Had he been brought back to the scene, he could have identified his own tracks leading down the ridge to the highway. The rescuers would have then known that the tracks leading down the gully below the avalanche debris were those of the other missing boy, Tom Bills. When Tom was found, he had been dead only a very short time. With better information, the rescuers could have begun following his footprints hours earlier. This action might have saved his life.

The critical need to obtain all possible information, and the consequences of failure to do so, are evident in this rescue effort. Apparently because of the boy's youth and the feeling that he had been through enough already, he was not closely interrogated. In retrospect, it is clear that the information he could have provided was vital to his companion. In addition, given the confusion that existed at the rescue scene, the rescue leader should have taken the initiative much earlier to question the survivor further and to check out the footprints. When all the facts are not known, all possible clues should be investigated thoroughly.

This accident was the fourth in a small area of the Wasatch Range in less than a month (see Nos. 67-4, 67-5, 67-6 also). The weather of the last few weeks—either heavy snow, strong winds, or both—kept hazard high by perpetuating slab formation. In back-country areas, a steep, uncontrolled, north-facing slope should always be suspect. In this case,

the evidence of past avalanches was a further sign that this slope was dangerous. The key to eliminating accidents of this nature lies in ed-

ucation: the general public needs to be taught avalanche safety techniques and the identification of dangerous avalanche terrain.

16 caught; 14 partly buried; 2 buried and killed

Weather Conditions

At the time of the accident on February 18, the sky was overcast and a 15 to 20 m.p.h. north wind was blowing. A noticeable drop in temperature had occurred shortly before noon as a storm moved into the area, bringing intermittent snow flurries.

Accident Summary

A Circle A Avalanche Training Course was being held at Skyline Ski Area near Bonnevile Peak about 20 miles east of Pocatello, Idaho. Instructors and enrollees of the course met Friday evening, February 17, for 3 hours of instruction on how to recognize signs of avalanche hazard, how to minimize danger, and how to travel through hazardous areas. Instruction was also given on practices to follow if caught in an avalanche.

On Saturday morning, the 18th, the party included Kieth Longson, the instructor, and the 30 members of the Circle A Avalanche Training Course. The group was scheduled for a practical exercise simulating the rescue of an avalanche victim.

During this morning session, the trainees received instruction in snow stratification and in techniques of probing for avalanche victims. While this was going on, another instructor, John Laffoon, and a local ski patrolman went to Green Canyon, a known avalanche area, where they buried a straw dummy. Laffoon and his companion buried the dummy in a deep snow deposit. Before leaving the site, the whole area was tested by shovel and skiing with no evidence of instability. After lunch, the entire group assembled at the bottom of the ski hill and awaited the simulated witness report that would mark the start of the exercise.

Upon getting the witness report at 1400, a hasty party of 11 people equipped with probe poles was organized and sent to the simulated avalanche area. The hasty party entered the area from the east, above the heavy snow deposit, arriving at 1435. Meanwhile, a main party was being organized at the base area to

follow the hasty party.

The hasty party flagged a trail into the simulated avalanche area. One man was posted as avalanche guard. The others probed on the face of the snow deposit and, after a few minutes, found the dummy. Instructor Laffoon told them to leave it buried so the main party could also carry out the simulated search-and-rescue exercise.

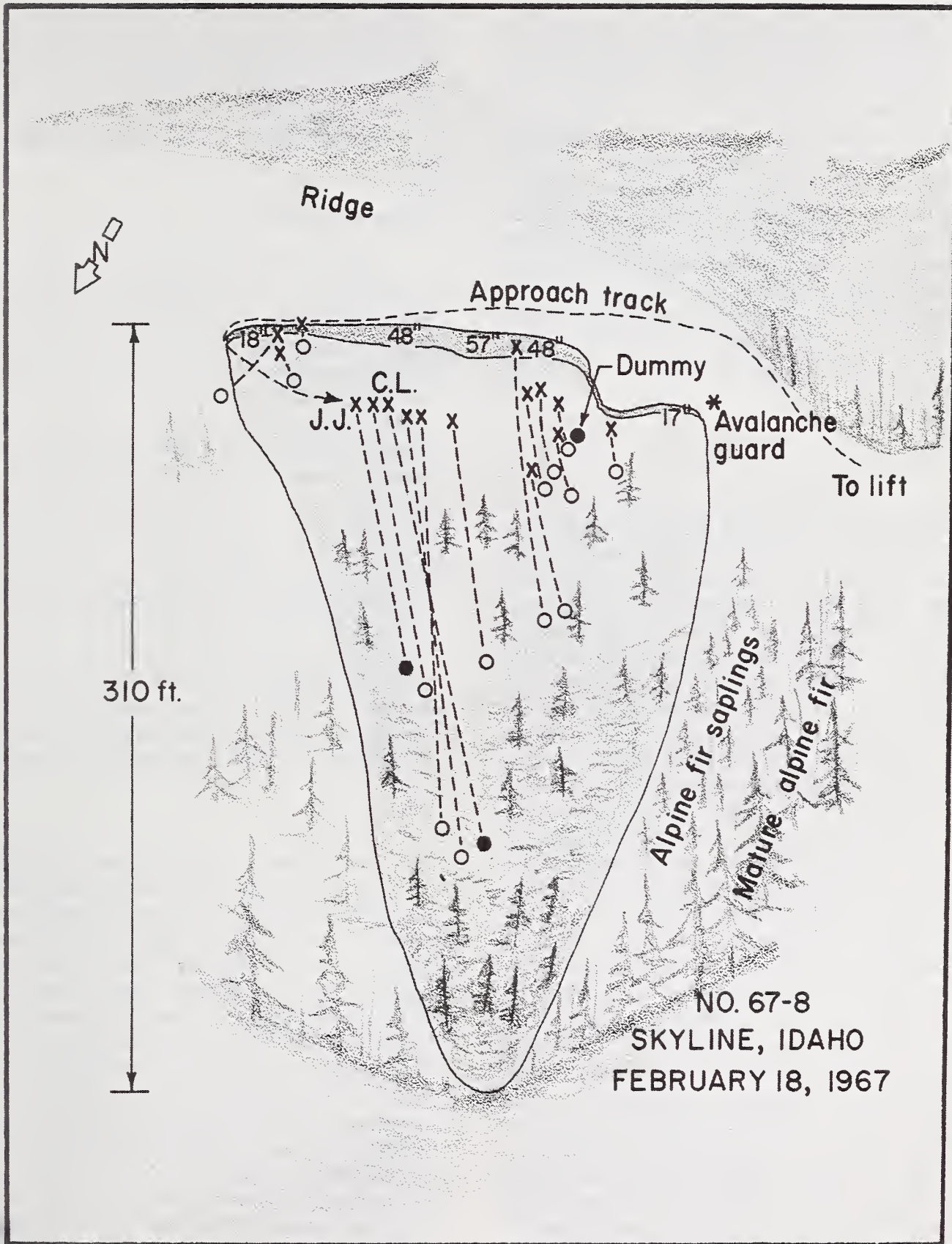
While the hasty party had been probing, the avalanche guard discovered a crack in the snow above the group and called this fact down. Immediately, Herman Torrano, one of the probers, climbed to the ridge to check on the crack. (The crack was an old glide crack which had been in evidence for nearly 2 months. It had been observed repeatedly by members of the ski patrol who shovelled and rounded the cornice weekly.)

By this time, members of the main party were arriving. This party had gathered their equipment and left the top of the chairlift at 1438 and arrived at the simulated avalanche area at 1445. Art Hendricksen, Skyline Ski Patrol Leader and leader of the entire rescue exercise, was with the main party. When he arrived at the site, he began organizing the party into crews of five and sent them into the avalanche area to probe for the "victim." He accompanied the first crew.

Meanwhile, Torrano called instructor Longson over to look at the crack. Longson looked over the edge at the probers below and became alarmed for their safety. He then made the decision to clear the area of all personnel.

He mentioned this to one of the main party but did not have time to relay this decision to leader Hendrickson. At 1450, just minutes after the main party had entered the slope, the snow suddenly fractured above the group. (The accident report does not state whether the fracture line coincided with the pre-existing crack.) Sixteen members of the group were caught and swept downhill for distances ranging from only 20 feet to more than 200 feet.

A head count was started immediately. About 5 minutes elapsed before those at the



top learned that two people were missing. The lack of a feminine reply to the head count indicated Carolyn Laffoon (wife of John Laffoon, one of the instructors) was missing, and the fact that John Johnson was known to be in the slide area but couldn't be located identified him as the other victim. While the head count was in progress, those who were caught in the slide were digging themselves out or helping dig out others who had been caught.

The force of the slide left probe poles bent and wrapped around trees. Avalanche cords were being used by members of the followup group but these were broken both by the force of the slide and by being swept through the trees. John Laffoon had his skis on and was standing in the southwest corner of the area when it slid. One ski was broken on his short downhill ride.

Rescue

Additional probes, shovels, ropes, and a toboggan had been called for by radio and were on the site or on the way. An avalanche guard was named for the rescue effort, and searchers were sent into the area. A hasty search was conducted with searchers probing likely spots for the two victims, mainly around and under trees. This search located the first victim, John Johnson. He was buried between 2 and 4 feet deep in the center of a group of saplings. His head was downhill nearly 4 feet under the surface of the avalanche. The snow was so compacted it was difficult to remove it from around his body. He was lying more or less on his right side. Some snow was packed in his eyes, nose and mouth. Mouth-to-mouth resuscitation attempts were begun at 1542 by Dr. Jim Sullivan. Closed chest cardiac massage was also used throughout these attempts but there was no sign of life. He was pronounced dead at 1547. Cause of death was listed as cardio-vascular failure resulting from suffocation. Johnson had no ice mask and there were no signs of attempts to free himself. He was removed from the area by toboggan at 1600 by members of the class.

The hasty search failed to locate Carolyn Laffoon, so a coarse probe was started. One coarse probe line was started at the bottom of the slide and another line was organized about 170 feet uphill from the bottom of the slide. After 15 to 20 minutes of probing, the lower probe line located the victim under 5 feet of tightly compacted snow. She was found at 1650 and was checked immediately by Dr. Charles Sternhagen. Her body was cold, face

was blue, and there was no pulse. She was pronounced dead at 1705. Cause of death was listed as cardio-vascular failure resulting from suffocation. There was a slight ice mask formed by body heat. At this point, all personnel except those working with the second victim were cleared from the area. The body of Carolyn Laffoon was removed from the scene in a Stokes litter by members of the rescue party.

Avalanche Data

This was a hard-slab avalanche classified as HS-AS-4. The fracture line was 220 feet wide and varied in depth from 18 to 57 inches. The slide carried 310 feet down the slope, becoming wedge-shaped and narrowing to 25 feet wide at the bottom.

The slope was a known avalanche path but was an infrequent slider. It faced north and was very steep, about 40°. The snow fractured at an elevation of 8050 feet. The slab was a very dense and compacted layer of wind-packed snow. Just below was a soft, cohesionless layer. A test pit had been dug on an adjacent slope at 1130. The stratigraphy was evident to the instructors, but they decided there was no immediate slide area.

The ridge top above the slope had a low brush cover. The slide area itself contained numerous trees; these were second-growth subalpine fir with diameters of 3 to 6 inches.

Comments

The lesson to be learned from this accident is obvious: simulated rescues should not be carried out on a known slide path unless the snow is known to be stable. In this case, three things may have lured the instructors into a false sense of security. First, even though the crack was present in the snow, some may have felt that, since the slope avalanched only infrequently and it hadn't failed this winter in spite of the crack, it was safe. Second, the presence of the tree cover may have indicated to those in charge that the slope couldn't slide. It should be noted that only a dense stand of timber can anchor snow to the slope, and the steeper the slope, the more closely spaced the trees must be. Third, the high-density hard slab found in the snow pit had probably convinced the instructors that failure could not occur in spite of the loose snow below. Indeed, the hard slab probably would have supported one or just a few skiers indefinitely. However, under the combined weight of no fewer than

16 skiers, the load was excessive and failure occurred.

Hard slab is a more difficult medium to work with than soft slab. The toughness of the slab often gives every indication of stability: test skiing is seldom effective on hard slab. A quick pit should be dug to determine the depth

of the slab and what sort of layers lie underneath. If any doubt exists, explosive control should be used. No explosives were used on this avalanche slope. This protective measure might have brought down the avalanche, thus revealing the danger and preventing the loss of two lives.

7 caught; 3 partly buried and 1 buried; 1 injured

Weather Conditions

One of the most popular runs at Alta, the Ballroom, is located under the east face of 11,068-foot Mt. Baldy. Skiers entering the Ballroom are threatened by several chutes that make up the east face. There are three types of hazards. First, the chutes are high-frequency avalanche paths themselves. Second, cornices form over the chutes and huge cornice blocks when released can travel down the chutes into the Ballroom. The third hazard involves falling cornice blocks which can trigger chute avalanches.

On March 22, 1967, the Alta snow rangers blasted the Baldy cornices. A hard-slab avalanche (HS-AE-3) accompanied the release of these cornices. In the past, one blasting operation per ski season had been sufficient to clear the cornice hazard.

The subsequent weather pattern was unique for the Alta area. There were 20 days of precipitation between March 22 and April 21 producing 111 inches of new snow and a water content of 10 inches. The snowfalls occurred mostly at night and at low temperatures (the mean low was 20°F). The April sun formed crusts rapidly during the day. The precipitation was ushered in by strong westerly winds, and the Baldy cornices were rebuilt to a hazard level. Six avalanches, ranging in size from 2 to 4, fell from Mt. Baldy in this period.

Accident Summary

At 0600 on April 21, the Alta snow rangers were advised by their supervisor (stationed in Salt Lake City) that he was coming up to direct the blasting operation of the re-formed Baldy cornice. Because of an unfavorable mountain weather forecast, the snow rangers expressed some reluctance to go on the mission but eventually consented when pressed by their superior. At 0730 the 75-mm pack howitzer was rolled out of the Forest Service garage, and four shells were fired below the cornices on the east face of Baldy. No slides occurred; the regions below the cornices were judged to be stable.

At 0900 a party of four men began the mission. In the party were Snow Rangers Ron Perla and Bengt Sandahl (inexperienced in cornice blasting); Ray Lindquist, their supervisor (experienced); and Chris Berry, an Alta ski patrolman. They left the top of the Germania lift and climbed to the summit of Mt. Baldy. They carried dynamite for 35 blast holes, a hole driller, and a Forest Service radio for communication with the Germania lift foreman. The summit was reached at about 1000. A decision was made to keep the Ballroom open while the cornice was being prepared for blasting. The ski run would be closed when the charges were ready.

Perla was instructed to move on a drilling line within 6 feet of the edge of the cornice and to drill 7-foot-deep holes spaced 9 feet apart. He noted that his drill was puncturing through the cornice, and he could see light through the hole. This was mentioned to Lindquist, but his only reply was that this happens occasionally in cornice drilling.

Perla was being belayed by Berry who started in a secure sitting belay position with a new 5/16-inch "Goldline" climbing rope. This was Berry's first attempt at belaying; he was very inexperienced.

The predicted bad weather moved in; the workers' toes and fingers became cold. To speed up the operation, Lindquist was belayed by Sandahl and joined Perla on the cornice. Sandahl was an experienced mountaineer and belayer. Lindquist had tied in to the other end of the 5/16-inch rope, the only rope available. All four members were essentially joined by one 5/16-inch rope!

Berry, affected by the cold, went into a standing belay position. Perla had drilled 23 of the 45 planned holes; Lindquist, following on the cornice, had filled these holes with dynamite. The time was 1120, and Perla was drilling his 24th hole while Lindquist was tying prima cord to the 23rd hole's charge. Perla and Lindquist had by now moved to a precarious position for their present belay.

Suddenly, the cornice collapsed! The fracture ran along the line of drill holes. Perla and Lindquist were straddling the drill holes

and went down with the cornice. Lindquist's belay held, and he was left dangling at the lip of the cornice. Perla's belay did not hold, and he fell along with the cornice into one of the larger Baldy chutes. The chute fractured and a size 5 hard-slab avalanche poured down on the Ballroom. Several skiers were in the Ballroom at this time.

The pressure of the moving debris against Perla's body was sufficient to snap the 5/16-inch rope. He was sent on an incredible 1500-foot ride. For the three others in the group, the rope snapping was a fortunate occurrence; the belayers were being pulled toward the brink, and the whole party would have fallen into the chute.

Perla describes his experience: "The cornice broke, and I waited for the belay to hold. It didn't, and I was in the chute. There were strong pressures against my body. The rope broke, and I was on my way. I knew it was a large avalanche. I tried to make swimming motions. The force of the snow against my face closed my eyes. The amount of time I was in motion seemed to go by quickly, and I sensed coming to rest. Next, I thought only of the snow piling on top of me, the amount of which would determine my survival chances. I realized I was face up. I tried to place my left hand over my face, but the piling up snow forced it away. However, before the snow set up, I was successful in getting my right hand up through the snow. The piling up of the snow ceased. I knew my hand was out of the snow and that I had excellent chances. I then tried to conserve air awaiting rescue, but almost immediately blacked out—the experience seemed painless, except for a firm pressure against my chest making it difficult to breathe. Returning to consciousness was a gradual process. At first it seemed I was able to breathe through the snow, then I saw figures standing above me. Finally, it became clear that the rescuers had found me and had opened an air space around my face. A slight headache due to anoxia and 3 days of stiffness were my only physical disabilities." (X-rays taken several years later for another illness revealed several vertebrae had been broken in the victim's back.)

Rescue

After losing his belay on Perla, Berry rushed to the aid of Sandahl. Together they were able to bring Lindquist up to safety.

At this time it was feared that several people, including Perla, were buried in the ex-

tensive debris. Lindquist shouted initial rescue instructions to skiers in the Ballroom area below and then began transmitting requests by radio for rescue assistance. A Forest Service dispatcher received Lindquist's message at 1130 and relayed the information to the County Sheriff. Three ambulances, a helicopter, and auxiliary rescue equipment were dispatched to the scene.

In the deposition zone below, a skier noticed Perla's outstretched hand, and with the help of another skier, uncovered Perla, who had been buried for about 2 minutes. He was evacuated to Watson Shelter, and given a doctor's examination. Three other skiers partially buried in the slide were also quickly extricated.

Lindquist remained on top of Mt. Baldy to secure the loose explosives. Sandahl skied down to the Ballroom to organize a hasty search operation for possible victims. The time was 1130. Sandahl coordinated the procurement of rescue equipment from the nearby Forest Service caches. A snow cat was used to deliver the equipment which included probes, shovels, marking tape, wands, four toboggans, and two oxygen bottles.

About 150 skiers assembled at the debris to volunteer for probe-line duty. A large percentage of these volunteers were ski patrolmen and ski instructors visiting Alta for the I.S.I.A. clinic. Lindquist skied down from the top of Baldy to supervise the logistics of the remaining rescue operations.

Four coarse-probe lines were formed to comb the massive deposition area, and eye-witness accounts were compiled to establish the possible number of buried victims. Witnesses confirmed that seven people were involved in the slide: Perla, the three who had been partially buried, and three others who had skied off without any help.

All seemed to be accounted for; however, one witness reported having seen two additional skiers caught in a deep deposition zone near the toe of the east end of the slide. On the strength of this witness' account, Sandahl organized a fine probe line of 60 volunteers to probe the area in question. The fine probe was begun at 1400, required 2 hours, and was not able to locate any trace of a victim. Throughout the duration of the search process, food and hot beverages were delivered to the volunteers by various Alta concessionaires.

Also, the County Sheriff and Forest Service personnel had been actively gathering and tracing down all possible missing persons. Road blocks were set up. Lodges were asked to

account for all their guests. Parking lots were checked. All people in the Alta area were accounted for by 1630.

Avalanche Data

This was classified as a HS-AO-5 avalanche. The falling cornices released an initial slab high on the Baldy chute and this in turn released several sympathetic slabs in adjacent chutes. The initial slab was about 4 feet deep, and it is hypothesized that it released on the sliding surface formed during the previous cornice blasting (HS-AE-3 on March 22, 1967). The sympathetic slabs varied in thickness from 1 to 4 feet. The debris, which varied in depth up to 12 feet, was scattered over the Ballroom and the upper Main Street areas. The slide ran about 1500 feet.

Comments

How was it possible for Perla to have survived this major slide? Some speculations are: first, that Berry held the belay just long enough to restrain Perla above the main debris; and second, Perla was thrown into an eddy that avoided blocks and carried him to a shallow deposition area. Finally, he was able to fall back on his avalanche training and do essential things at the right moments. Luck was with him also in allowing his outstretched arm to break through to the surface when the slide stopped.

Perla had with him an additional safety device—the broken belay rope—that should have led rescuers to him had he not been able to get a glove above the snow. The rope was at least 50 feet long and should have served as an avalanche cord; however, the entire length of rope was buried beneath debris. In this case, both Perla and the rope had nearly come to rest on top of the snow when snow from above buried him and the rope. This is one example of how an avalanche cord can be buried along with its user and is enough to cast doubts on the reliability of avalanche cords.

Several classical mountaineering errors were made:

1. The group set out to accomplish an extensive mountaineering project despite an unfavorable weather forecast. (Ironically, the group was cognizant of the weather forecast and had expressed reluctance to go on this mission.)

2. The group was not equipped for bad weather.

3. The group used an undersized rope. A 7/16-inch (11-mm) rope should have been used.

4. Two people were belayed on the same rope.

5. Two people were on the same cornice at the same time.

6. The belayer was not experienced and did not assume a stable position.

7. The drillers straddled the drill hole line instead of standing behind it.

The blasting party failed to evaluate the instability of the cornice. They were misled by the stability of the cornices when first blasted in March. The March cornices were mostly vertical or only slightly overhung. The April 21 cornices had a more pronounced overhang, possibly due to a plasticity caused by the intense solar radiation during April.

Another important contribution to this accident is the fact that a cornice that has reformed after the primary winter cornice has been removed is much less stable than the first one. A mature cornice is held onto the mountain by tensile strength of the continuous layers of snow running back into the cornice. In a re-formed cornice, these layers are not continuous. A dangerous discontinuity exists where the new cornice formed on the fracture line of the old, a discontinuity that lies precisely at the zone of maximum stress.

Another contribution which added to the group's misplaced confidence was the early morning pack howitzer firing below the cornice area which released nothing. It is interesting that the falling cornice accomplished what the pack howitzer could not—the release of a size 5 avalanche.

Cornice blasting is, by its nature, a dangerous task: working too far back from the edge can be ineffectual. Blasting crews must always be aware of their vulnerable position on the cornice. It is recommended that an observer be stationed at a location from which he can observe the undercut of the cornice. He can then call positioning instructions to the workers on the cornice. In addition, whenever possible the cornice worker or the belayer should be tied into a fixed anchor—rock, tree, lift tower, etc. In many cases, a standard belay cannot hold against the force of falling cornice blocks and avalanche snow.

Finally, two policy changes at Alta were made because of this accident. First, a great gap in the training of new avalanche men was revealed. A more thorough training program was initiated to increase the skills of the avalanche workers. Second, the Ballroom is no longer left open to skiers while blasters are working on the Baldy cornice above. Of all the mistakes made, this was the worst.

*1 caught, buried, and killed***Weather Conditions**

Through November 25, 39 inches of new snow had been recorded for the month at the weather site on the east side of Loveland Pass, 4 miles from the Arapahoe Basin Ski Area. Twenty-five inches of the total had fallen in the last 5 days with a water equivalent of 1.61 inches. The winds during this 5-day storm period were westerly and averaged 18 m.p.h., but gusted to over 50 m.p.h.

Sunday, November 26, broke clear, cold, and windy. Before sunrise the temperature was -2°F. A maximum of 14°F was recorded at 1400 with a rapid fall in temperature after that time. Winds were strong and gusty all day, blowing from the WSW, averaging 16 m.p.h., and again gusting to about 50 m.p.h.

Accident Summary

Earl Gentry, 39, was a National Ski Patrol member who had been patrol leader at Arapahoe Basin during the 1966-67 season. He had earned an avalanche patch from the National Ski Patrol system and was considered a competent skier and patrolman. On Sunday, November 26, Gentry signed on for duty at Arapahoe Basin as a volunteer patrolman. He was assigned two one-half hour duty stations, one in the morning and one in the afternoon.

On the morning of the 26th the ski patrol thoroughly checked out the area with skis. No explosives were used. Conditions were found to be extremely wind-blown, with heavy deposition on the lee sides of ridges and very wind-crusting conditions. No avalanche activity was noticed, nor did the ski patrol get any kind of activity from their skiing. The area was opened for business and was lightly skied during the day. After the lifts had closed, Gentry began his "sweep" with the other patrolmen.

Gentry and five other ski patrolmen were sweeping Lenawee Mountain in pairs of two; his partner was Gail Kersion. They separated from the rest of the group on the upper part of the mountain. They were assigned the Lenawee Glades. At the top of the Lenawee

lift, Gentry saw tracks going into one of the glade areas. They decided to separate, with Kersion going down the west gully, and Gentry checking out the ski tracks more closely. They agreed to meet at the upper meadow. The time was about 1615.

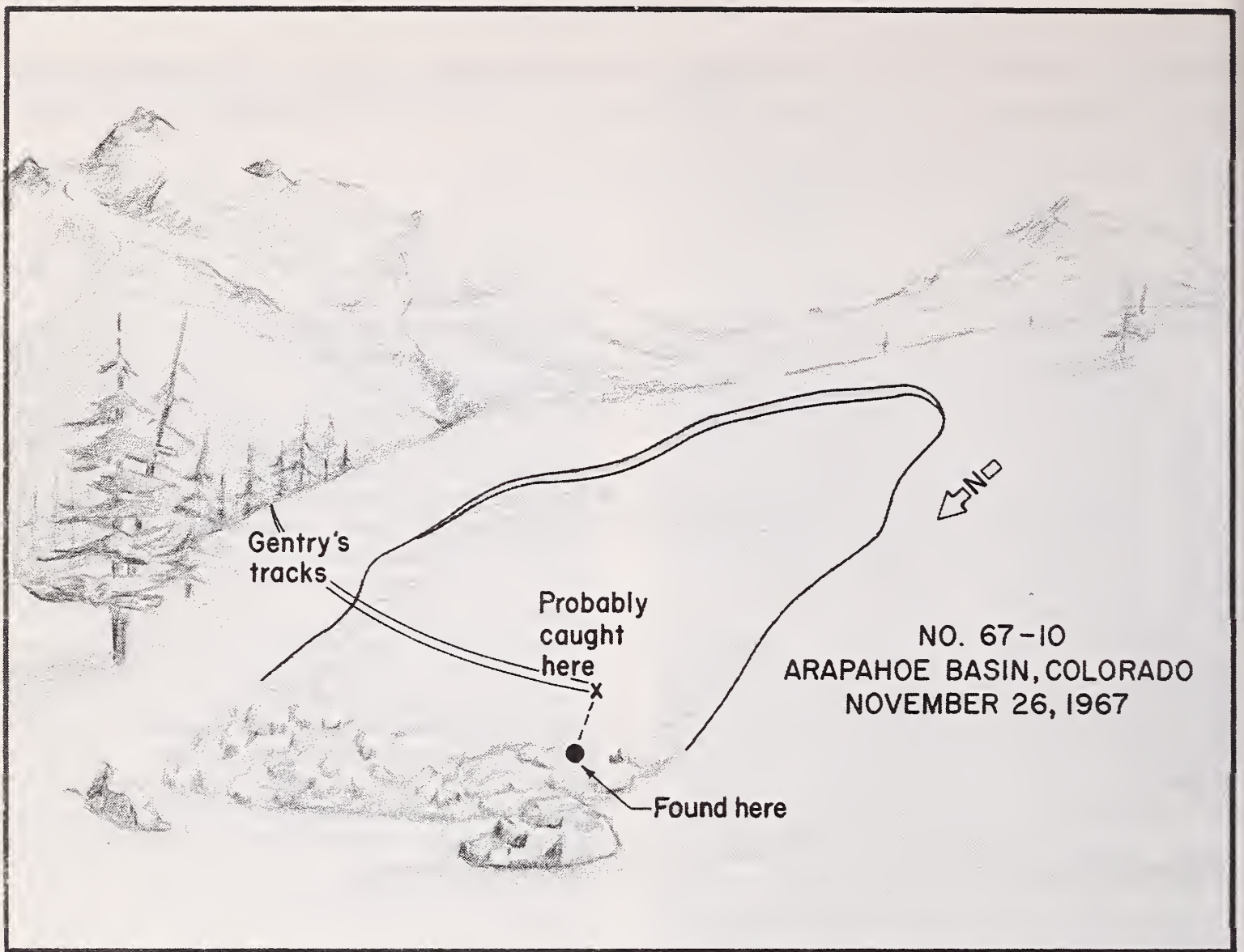
Kersion got down to the upper meadow in approximately 5 to 10 minutes and waited for Gentry. When he did not come, she called several times and got no answer. She then walked up toward Midway and looked up the area where Gentry should have been. She saw no one. She called again, but got no response. This took approximately 10 minutes. The light was beginning to fade, and she decided she had better get down. She thought possibly Gentry had gone on down before her. She arrived at the patrol room in approximately 10 more minutes, and found that Gentry had not arrived there either.

Rescue

The "super-sweep" patrol was alerted at the top of the mountain. The super-sweep is a back-up system where two patrolmen are left at the top of the mountain until all patrolmen report in at the bottom. Their purpose is to assist patrolmen who get in trouble, and also bring a toboggan if any patrolman finds an accident during the sweep.

The super-sweep team of this day was Will Green and Margie Lincoln. They proceeded to the Lenawee area after the phone call indicating Gentry's disappearance. Green was the first person to reach the area of the accident. He found that skiing in the Lenawee area was difficult and dangerous due to drifts and wind crust. Near the head of the west gully they found a set of tracks, which they took to be Gentry's. These tracks were following the route that is taken by most skiers who want to return to the Drummond Lift from the Lenawee area. The tracks were partially obscured by blowing snow and were the only tracks noticeable in the area. They stopped and called twice, but got no reply. The set of tracks ended at the edge of a fresh avalanche.

Toward the lower part of the avalanche,



they could see the front half of a ski sticking out of the snow. When they reached the ski they could see a rust-colored parka through cracks in the snow blocks, and surmised that it was Gentry. They quickly uncovered his head and chest. Green started mouth-to-mouth resuscitation, while Lincoln went for help.

The victim was found on his side and partially on his back under about 1½ feet of snow, facing sideways. His left ski boot was almost out of the snow, and part of his left ski was sticking out of the snow. He was wearing a crash helmet or racer's helmet, which was still on his head. His mouth and nose had no snow in them and his air passages were clear. He had no ice mask. There was discoloration of the snow near his nose and mouth; it is not known whether this was blood, or what caused the discoloration. The snow in the slide was loose enough so that it could easily be scooped away with the hands.

At approximately this same time, four

patrolmen started up the chairlift with oxygen. When these patrolmen arrived at the scene, artificial respiration was still being administered. The victim was still partially buried at that point, and the patrolmen completed unburying him. Shortly thereafter, the first doctor arrived. At the time the doctor arrived, mouth-to-mouth resuscitation and closed-chest cardiac massage was being performed. At approximately 1800, the victim was declared dead.

Avalanche Data

This fatal slide was classified as HS-AS-1. The slide ran about 150 feet down a 31° slope (37° in the starting zone). The slide was only about 25 feet wide at the starting zone and about 90 feet at its widest. The fracture line was about 22 inches at its deepest point, and the debris consisted of angular snow blocks of various sizes.

Extremely hard-packed, wind-crusting snow conditions existed; some deposition areas were so hard that the handle end of a ski pole could not be thrust through the surface. Many deposition areas sounded hollow (like a bass drum) under ski. Some of the deposition areas had fractured on their own accord but had not slid. It looked as if these had fractured the evening before or during the night. The first rescuer along the road above the avalanche site got a small fracture from his skis as he neared the avalanche site.

Examination of the snowpack in the fracture zone revealed the following conditions: The depth of snow on the ground was shallow—slightly more than 20 inches—and in places the avalanche dug to the ground. The fracture line itself was approximately 16 inches deep. Just above the ground lay 5 inches of well-developed depth hoar. The depth-hoar crystals were particularly large and could actually be photographed without the aid of a special lens for the camera. Above the depth hoar was a thick layer of fine-grained old snow (equitemperature-metamorphism crystals). A hard, dense wind crust formed the surface of the snowpack.

Comments

The snow that fell early in November, because of its very shallow depth, developed into depth hoar. On the 20th of November, snow began falling again, accompanied by strong winds, and this developed a hard-slab situation. The patrol skied over this slab the morning of the 26th and got no activity, and the light skiing during the day resulted in no activity. The slab was so hard that skis would barely penetrate it.

The area of the avalanche is a north-

facing slope and receives very little sunlight during the day. A sharp temperature decrease occurred during the 2 hours immediately preceding the slide. From 1400 to 1600, the temperature fell from about 14° to 4°F. This temperature decrease may have increased the tension of the slab, thereby increasing its instability. This may explain why the slope avalanched under Gentry's weight while not releasing when skied earlier in the day.

There is a debate among researchers and field personnel over the mechanism labeled "temperature release." Presently there are no data to indicate the magnitude of the expansion or contraction created within the snowpack by temperature changes. Some researchers believe that great instability can be induced by temperature changes but others believe the effect is negligible. In any event, it should be noted that temperature-gradient crystals (in this case, depth hoar) have been found in almost all reported cases of "temperature release."

A further note should be added: test skiing is often ineffective under hard-slab conditions. Explosives give a more reliable test of hard-slab instability. The hollow sound beneath the snow and the appearance of cracks in the snow should have alerted the patrol of the hazard in the area in spite of the test-skiing results.

It appears that Gentry was probably caught by surprise. The fracture line was about 75 feet above the point where he entered the slope. Brittle failure probably occurred with the whole area fracturing at once into large blocks. The slide pushed him over (head downhill) and slid over him. He could not have been carried more than 10 or 15 feet. The weight of 1 to 1½ feet of snow was sufficient to hold him down.

*1 caught and partly buried***Weather Conditions**

Snowfall this winter had been much below normal in the Cascades. On January 27, snow depth was 45 inches at Alpentel; twice this amount would be present in a normal winter. On the 26th, 8 to 12 inches of snow had fallen on the upper mountain with the temperature holding near 25°F. Winds of 10 to 15 m.p.h. had blown without transporting much snow. The 27th dawned clear and much colder.

Accident Summary

Early Saturday morning, January 27, four patrolmen set out on their control route. All but Terry Holdy were experienced in avalanche work. The crew was skiing into Edelweiss Bowl from the top of Chair No. 2 with the objective of test skiing or hand charging several small chutes which were uncontrollable from the avalauncher position.

At 0730, they reached a small 35° chute in the bowl. One patrolman threw a hand charge up into the chute and then all except Holdy retreated to cover in nearby timber. Holdy took cover behind a tree but not nearly as far away as the other three men.

The explosion set the chute in motion and also released a sympathetic slide in the trees.

The snow fractured 50 feet above Holdy and swept him away from where he was standing. He was carried 50 feet downhill and buried waist deep. Immediately his three companions skied downhill and helped dig him out; he was uninjured.

Avalanche Data

The slide was a small, sympathetically released slab. The fracture line was 1 foot deep and 50 feet long. The slide moved about 150 feet down the slope.

Comments

Holdy's lack of experience led to trouble in this incident. The other three patrolmen had retreated far enough away so that the sympathetic slide did not affect them. Holdy also felt that even though he was not as far away, the timber on this slope would keep it from sliding. This confidence was unfounded; the timber was not nearly dense enough.

After this incident, the Edelweiss Bowl was no longer controlled from below by hand charging. This kept the bowl closed for a large part of the winter. A recoilless rifle has since been installed to control this area.

Edelweiss Bowl

Explosion point



Shot thrown from here

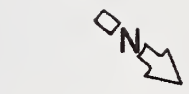


Holdy



Other three patrolmen took cover here

Buried to waist



Route from top of Chair 2

NO. 68-1
ALPENTAL, WASHINGTON
JANUARY 27, 1968

2 caught, 1 partly buried

Weather Conditions

A major storm moved inland on January 30 bringing moderate but continuous snowfall to the Cascades. During the 5-day period from January 30 to February 3, 36 inches of new snow containing 4.00 inches water equivalent fell at Stevens Pass; this increased the snow depth from 39 to 57 inches. In addition more than an inch of rain fell on February 2 and 3, adding to the hazard. Moderate westerly winds caused light drifting.

Accident Summary

At 0800 on February 3, Snow Ranger Bob Lawrence, Assistant Snow Ranger Gert Gruenwoldt, and pro patrolman Merle Bergren skied away from the top of Chair No. 1 to do the last remaining avalanche control work of the morning. They entered a slope called the Headwall, a northeast-facing bowl that had loaded up heavily with wind-transported snow. Bergren threw a one-pound block of HDP onto the slope. The charge hit the wind-packed slope, did not penetrate, and rolled on down the slope to explode ineffectively. Because this was the last charge the group had with them, they decided to "ski off" the slope.

Bergren went first, followed by Gruenwoldt and Lawrence. As Bergren worked his way down and across, the snow suddenly fractured 20 feet above him. The moving snow

knocked him off his feet and swept him to the bottom of the slope, a distance of 200 feet. He was buried to the waist and was able to free himself.

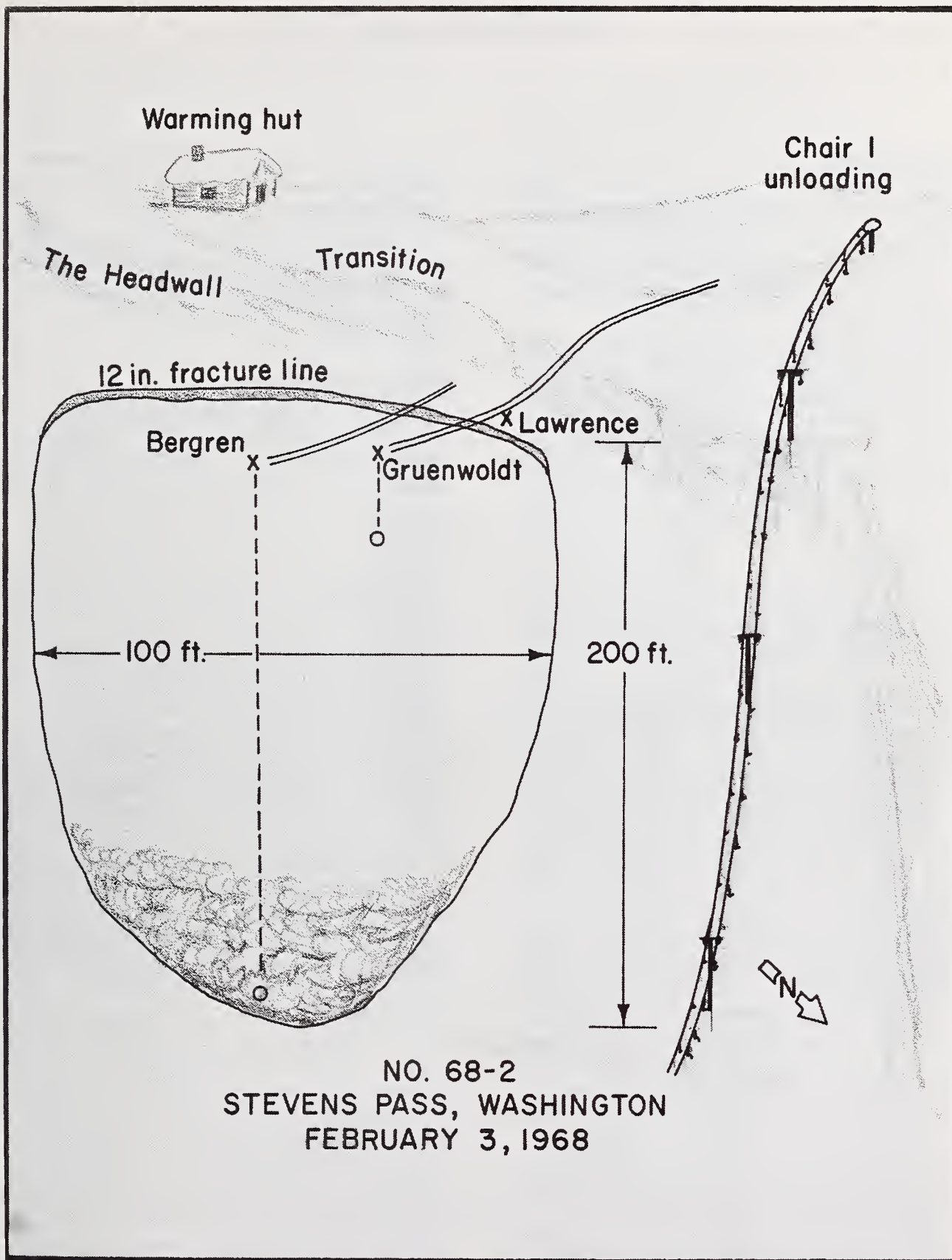
Gruenwoldt was behind Bergren and slightly lower on the slope when it fractured. He was carried approximately 10 feet before he was able to arrest himself with a ski pole. Lawrence, last in line, was standing on the fracture line and was able to step back out of the moving snow.

Avalanche Data

This slide was a SS-AS-3. The 12-inch fracture line extended across most of the width of the slope for a length of 100 feet. The slide carried 200 feet downhill and piled debris several feet deep in the runout zone. This path is an active one, running several times each winter.

Comments

The Headwall is too big a slide path to be ski checked safely. The control team knew this, but when they ran out of charges they decided to ski it anyway. In the interest of safety at the expense of time, they should have skied down and returned to the slope with some extra HDP blocks. A shot cord attached to the charge is effective to hold the charge on the slope when the snow is hard.



*1 caught and buried***Weather Conditions**

Ten inches of new snow fell at Alpental on February 1 to 3. This was followed by 2.75 inches of rain on the 4th during which time 24 natural wet slides, all medium to large, ran in the ski area.

Four days of clear, sunny, and mild weather followed. Moderate west to north-west winds had blown during this period. The morning of February 8 broke clear with a temperature of 22°F. Snow depth was 59 inches, a settlement of 7 inches over the last 6 days.

Accident Summary

At 0800 on the 8th, three pro patrolmen departed Chair No. 2 to check out Edelweiss Bowl and the adjacent ridge runs. Terry Holdy (see No. 68-1) was one of the group and still was considered inexperienced in avalanche control work.

The party was test skiing and hand charging many small chutes and gullies and had not had any significant results. They reached a small chute beneath Chair No. 2 and decided to test ski it. Pat Bauman entered high in the chute, and at the same time, Holdy entered below him. Bauman released a small slide which caught Holdy below and knocked him off his skis. The fast moving snow engulfed

Holdy and carried him 100 feet down the chute. He was buried horizontally under about 1 foot of snow.

Bauman and the other patrolmen immediately skied down the chute and dug Holdy out. He was badly shaken up but unhurt. He had lost one ski pole in the slide.

Avalanche Data

This slide was a L-AS-1 that slid a little more than 100 feet. The gully was only 30 feet wide. Snow sliding in this gully funnels down and piles debris deep enough to bury a man easily.

Comments

The error here was made in not informing a new man on the proper procedure of test skiing. He should have never entered the narrow chute while another skier was in it. The gully was especially dangerous because even a shallow slide would make a deep deposit below. It should not have been test skied without a belay.

This was the second time in 11 days that the victim had been buried in a slide (see No. 68-1). Both accidents resulted from his inexperience and from lack of proper guidance from the team leader.

*1 caught and buried***Weather Conditions**

Weather records from Aspen Mountain showed that slightly below normal snowfall had fallen this winter through the middle of February. On February 12 and 13, 9 inches of snow fell and 4 more fell on the 15th, bringing the snow depth to 46 inches. The temperature ranged from 16° to 24°F on the 15th, and light and variable winds were blowing. The winds had been westerly and considerably stronger the previous two days.

Accident Summary

On the morning of February 15, Bill Flanagan, a ski patrolman and lift operator, at Aspen Highlands, and Matt Wells, a ski patrolman, left Loge Peak at the top of Aspen Highlands Ski Area. They were headed for Highland Bowl to check on snow conditions and to ski the powder if conditions were stable.

Highland Bowl is an enormous, open bowl on the east flank of 12,381-foot Highlands Peak. The bowl is several thousand feet across at the top and descends nearly 4000 feet vertically to Castle Creek. The top of the bowl has no trees and a slope of about 35°. There is evidence that huge avalanches in the past have run the entire distance to Castle Creek. The bowl is beyond the ski area boundary and is not frequently skied. Flanagan gives a chilling personal account of what happened on this particular morning.

"Matt and I started down along the right (south) shoulder of Highlands Peak at approximately 1100 the morning of February 15. The virgin powder was very dry and light but so deep that we found we were unable to ski fast enough to make turns. That right shoulder simply didn't have enough pitch. So we swung out into the open bowl, staying just to the left of the first finger of growth running up the face.

"We stopped at the top of the very face of the bowl and threw a 7-stick, 40% charge down into the path we intended to take. The detonation had no effect, however. An earlier charge

of the same size which we had pitched into the face from the top of the peak had released nothing either. Having witnessed this, we were confident the snow would hold up so we started making turns down a pitch which I would estimate at 35°.

"I made perhaps three or four turns before stopping to photograph Matt as he came down. He stopped just below me and we agreed that I'd ski a bit farther down and shoot up my film as he came down to me.

"I had made perhaps three turns when I leaned uphill too much and fell back into the snow. I started to sit up and had looked up at Matt, who was perhaps 30 to 40 yards above me, when it broke.

"Matt recalls that it fractured just below him. I can recall that the snow seemed to suddenly settle and I noticed several 'whirlpool' effects in the snow surface around and above me.

"I was rolled under almost immediately, and breathing hard as a result of the deep powder skiing, my mouth immediately filled with snow as I attempted to breathe. Try as I did, it was absolutely impossible to expel the snow from my mouth. The ball of snow simply packed harder each time I tried to gulp air around it.

"I recall I was able to swim and did so as naturally as one would were he trying to surface in a pool of water. I recall only a 'whooshing' sound of sorts and it gained speed incredibly fast. It seemed I knew where the top was because it seemed there was always a lighter side. I had started out with my pole straps over my wrists but can't recall when I lost my poles.

"Suddenly the pressure increased tremendously. I recall having the thought, 'Not me, not this way, not like this.' But it squeezed so terribly that I was unable to move arms or legs and I must admit that at this point I literally gave up. The pressure was so great it just forced that thought into my mind. (For some time after, recalling that thought would sit me bolt upright in bed at night.)

"A terrific drag suddenly built up on my right leg and was just as suddenly relieved when the ski tore off. I remember realizing

this even as it happened, and I know that this is the important reason for my surviving this horror. Once free of that ski I started rolling again, and almost immediately the terrific pressure began to ease and I was again able to swim, or at least move my arms.

"I remember that it slowed down and then stopped very quickly. I felt it lighter above my shoulders and struggled my arms loose and broke through to daylight.

"The ball in my mouth was so big and hard I was unable to get it out from behind my teeth. I was able to crush it bit by bit with my front teeth and finally reduced it to a size I could at last spit out. I then dug my legs free, released the left ski and stood up.

"I realized immediately why the pressure had increased so suddenly when I looked back up the slide path. I could see only about 100 yards of the deposition. From there it climbed abruptly to the left up the sidewall of the bowl. I knew that it piled up on itself as it dove into the floor of the bowl, and I must have been quite deep at that particular moment.

"I would estimate the length of the slide at somewhere between 400 and 450 yards. I shouldn't think that it ran for much more than 10 seconds as I'm quite sure that had it been much longer than that (15 seconds at best), I certainly would have passed out for lack of air. As I said, I was breathing heavily even as it broke. My throat was so sore that taking a breath actually burned, and for a good half hour I couldn't draw a full breath.

"I figured that I was still in plenty of trouble. I had no poles and only one ski with several miles of chest deep, untracked snow to negotiate down to the Castle Creek Road, but then I spotted Matt high up on the rim of the bowl. Until then I wasn't completely sure that he hadn't been caught and carried down too.

"I was standing at the bottom of an enormous bowl whose walls were nothing but uninterrupted open snow just needing the slightest trigger to bring them down. I was reluctant to move off the slide path knowing that I would just flounder in the unpacked snow. Matt spotted me and, in spite of the danger, managed to get down to me. Thinking it over later, I realized that was the bravest thing I had ever seen done. Matt and I are the

fastest friends since that day.

"He gave me his poles, and after many hours of agonizing effort we made it down and out to the road."

Avalanche Data

This avalanche was a SS-AS-3. It slid on the north-facing wall of Highland Bowl for a vertical fall of about 800 feet. If Flanagan's estimates of the length (400 to 450 yards) and duration (10 to 15 seconds) of the slide are close, the avalanche traveled between 55 and 90 m.p.h.

Comments

Flanagan offers these comments: "This was one of those rare cases where a fool makes every foolish mistake in the books but somehow lucks out. One look at that pitch should have told me that under the conditions, as steep as it was, it would never hold up. The wind and drift factor that bowl gets make it absolutely unskiable almost anytime. I'm wiser now but far more importantly, I'm still terrified. My fear alone should keep it from happening again."

Flanagan was indeed fortunate to break through to the surface just as the slide was stopping. Had he been completely buried, he probably could not have moved enough to dig himself out. With his mouth full of snow, he would have certainly died of suffocation before being rescued.

Many victims killed in avalanches are found with their mouths full of snow. Flanagan's experience shows how easily avalanche snow is inhaled. An avalanche victim's chance of survival is increased if he can keep his mouth closed while in the snow.

In this instance, when the snow tore off Flanagan's right ski, his chances of survival were increased. Being less restricted, he was able to make a thrust toward the surface when the snow slowed down. With the ski on, he may have been held beneath the surface. In other accidents, skis remaining attached to a buried victim have protruded above the snow surface allowing rescuers to locate the victim quickly.

2 caught; 1 partly buried and 1 buried; 1 killed

Weather Conditions

Weather records at Alta, Utah indicate that the winter of 1967-68 began with extremely light snowfall in November, followed by above-normal December snows. January 1968 followed with less than half its normal snowfall.

Snow began falling in the Wasatch on February 12 and continued on and off for the next 14 days. By the 20th, more than 40 inches of snow had fallen bringing the depth of snow on the ground to near normal. A warming trend late on the 19th brought rain to the western slope of the Wasatch at elevations below 7500 feet. In Rock Canyon, just east of Provo and about 20 air miles south of Alta, rain was falling on top of several inches of new snow on the evening of the 19th.

Accident Summary

On Monday night, February 19, the members of Boy Scout Troop 40 in Provo, Utah had their weekly meeting. After the meeting, three scouts—Robert Breckenridge, 12; Brian Tolman, 13; and Gordon Duke, 13—and assistant scoutmaster Don Hamilton, 29, decided to take a short hike up Rock Canyon on the east edge of Provo. Edison Breckenridge, Scoutmaster and father of Robert, drove the group to the mouth of the canyon and said he would wait until the hikers returned. Tolman gave the following account of the accident. The time was about 2030.

“We went up the mountain and hiked about three-quarters of a mile up the canyon. Then we sat down and rested. We were talking and throwing snowballs across the creek.

“I heard this rumble. It was a big noise—pretty loud. I looked back of us and saw this big mass of snow coming. It was bumping and flying over the rocks higher above us.

“Gordon and I jumped up and just began running down the trail. We ran as fast as we could for about 100 yards. During this time, I didn't see Robert or Don.

“We stopped and yelled back. We heard Don yell back. He said he was trapped in the

snow. We waited for a minute. It seemed like there was still snow coming down. Then we went back.

“Don sent Gordon down the canyon for help. Don couldn't move, so I broke off a big stick and began digging to get him out. It took about an hour to dig away the snow so Don could get out of the hole. I just never did see Robert again.”

Hamilton related his experience: “I first heard a noise like a jet aircraft overhead but saw nothing. The next thing I felt was the snow engulfing me. I swam like crazy just trying to keep my arms and legs from being trapped. I saw Robert slightly to my left as the snow hit but never saw him after that.”

In all, two of the scouts escaped the avalanche completely, Hamilton had been buried to the chest, and no sign at all could be found of Robert Breckenridge.

Rescue

Gordon Duke came running out of the canyon and told Edison Breckenridge, who was waiting in the car, what had happened. They raced down to Provo and notified the Utah County Sheriff's Office. They hurried back to the scout meeting headquarters and organized some Explorer Scouts into a rescue party. Meanwhile at the accident site, Hamilton and Tolman had found no sign of Breckenridge. The debris appeared to be 15 feet deep in places.

The sheriff notified the Utah County Jeep Patrol, the Timp Haven Ski Patrol, the Alpine Rescue Club from Brigham Young University, and the Alta Ski Patrol. Flashlights, gasoline lanterns, probe poles, and shovels were carried up Rock Canyon to the accident scene. A Caterpillar tractor was also sent up the canyon to push away some of the debris. A snow cat also was pressed into operation ferrying men and equipment up the canyon.

Several probe lines were set up. At 0230 on Tuesday morning, February 20, the body of Robert Breckenridge was found by the probers. He was found under 10 feet of snow and had died of suffocation. He had been buried 6

hours. About 150 volunteers had participated in the futile rescue.

Avalanche Data

This was a natural avalanche that had released well above the group. Most likely, it was a wet slide resulting from the rain falling on the recently deposited snow. The slide came off some high cliffs and fell into the narrow canyon where the party had stopped. It was about 100 yards long and about 50 yards wide. Some boulders and trees were carried down by the avalanche.

Comments

This tragedy resulted from the scouts being simply "in the wrong place at the wrong time." This being such a short hike, the group

had not even thought of avalanches. The hazard of their resting place—at the foot of a row of cliffs heavily laden with snow—was concealed in darkness. Hiking or touring groups should never knowingly pause beneath apparent avalanche paths but should move rapidly across the runout zone.

The effectiveness of swimming is demonstrated by this accident. Scoutmaster Hamilton swam vigorously with the snow; this gave him some maneuverability and apparently saved his life.

During the rescue, many of the rescuers were fearful of more avalanches falling from adjacent cliffs. This case offers an example of a nighttime rescue mission being carried out during high avalanche hazard. It is a hard and critical decision that the rescue leader must make: the safety of many rescuers must be carefully weighed against the chance of recovering the avalanche victim alive.

1 caught and partly buried; 1 chairlift damaged

Weather Conditions

Warm weather preceded a storm which began on February 19 in the Bridger Range of Montana. On February 18 and 19, temperatures were generally above freezing, with some rain occurring on the 19th. Snow pits indicated that south slopes had become isothermal, and the presence of ice crystals in the pack on February 21 indicated that there had been free water present. No wet slides had occurred however. North-facing slopes were not quite isothermal. Only a little depth hoar was observed.

A warm Pacific storm moved in on February 19 with rain that turned to graupel and then continued as mixed graupel and rimed snow. The snow line and freeze elevation during the storm was at the base of the Bridger Bowl Ski Area or somewhat below. The warm temperatures caused the new snow density to be high, estimated at 15 to 22 percent. Snowfall during this storm was 14 inches on February 20, 2 inches on the 21st, and 10 inches on the 22nd.

The average windspeed exceeded 15 m.p.h. for the period between noon on February 19 and 2000 on February 20; peak gusts were well over 50 m.p.h. Perhaps because of the high-density snow that was falling, there was little evidence of wind-transported snow below the highest ridge. Wind direction was south to southwest, and four northeast-facing slopes slid naturally during the night of the 19th.

Snow pits dug on the 21st revealed at a depth of 16 inches a graupel layer resting on a hard, stable layer below. It was felt there was some bonding between the new snow and old surface. Test skiing did not release any slides; however, cracks were observed running ahead of skis, an indication of slab conditions. No explosives were used.

Snow continued to fall on the 22nd; this snow also was graupel and heavily rimed crystals. No sluffing had occurred, and the possibility of widespread slab conditions was recognized even though there was little evidence of wind-transported snow.

Accident Summary

On Thursday morning, February 22, Snow Ranger Don Michel and District Ranger John Butt arrived at Bridger Bowl for control operations at 0800. It was not until about 0845 that the lift operator arrived at midway to start Chairlift No. 2 (now called the Alpine Lift), and the avalanche control crew went up the hill. Due to the new snowfall and the indications of instability observed in snow pits the previous day, both upper hills were closed. To save time, the group crossed Bridger Gully to the North Bowl gun and arrived at about 0915. Clouds restricted visibility to an area 500 feet below the ridge. Six rounds were fired with the following results.

As a warning to alert the lift operators, the first round was fired into the middle of Bridger Gully, about halfway to the top. No release or movement of snow was observed. The second round was fired at the southeast-facing slope of Bridger Gully. This released a large slab (SS-AA-5). A secondary fracture line ran south across the lower cliffs of Bridger Gully to the edge of the North Bowl under the power line, releasing the area that the crew had just traversed. Another fracture ran south across the two-thirds point of Bridger Gully. A third secondary fracture continued around the ridge to the north above Chairlift No. 2 motor room and 100 yards into the Northwest Basin. Butt saw a dust cloud near the lift shack and was concerned. They looked through the gun sight and could see the operator shack was not damaged. Trees restricted their view of the motor room, however, and it could not be determined if there was any problem.

The third shot from the 75-mm rifle was placed on the northeast-facing slope of Bridger Gully, about two-thirds of the way to the top and 100 yards above the last fracture line. This released another slab in Bridger Gully, as expected; however, a secondary fracture first ran a quarter mile across the lower cliff of the North Bowl. Then another fracture line ran across the North Bowl at the ridge line, releasing two-thirds of the entire

North Bowl. A loud roar accompanied this avalanche (SS-AA-5).

The fourth shot from the 75-mm rifle was placed about 200 feet down from the top near the southwest corner of the North Bowl. This released about one-fifth of the North Bowl in that area (SS-AA-3), but it did not release the area below the "catwalk." The "catwalk" was not shot with the rifle because it is too close to Chairlift No. 1 (now called the Bridger Lift).

The clouds lifted briefly, and another shot was placed about 100 yards below the ridge in Bridger Gully. This released another slab from the upper slope (SS-AA-3).

The sixth shot was placed high on the ridge between Bridger Gully and the North Bowl above the fracture lines. Another slab was released which descended into both the North Bowl and Bridger Gully (SS-AA-3). The firing was finished at about 1030.

By this time the gun crew was aware that Chair No. 2 had not yet begun running and felt that something must be wrong. While they were cleaning the gun, a patrolman skied over with the news that the top terminal of Chair No. 2 had been hit by a large avalanche. He said that apparently no one was injured but the motor room had been destroyed. Michel and Butt then skied over to Chair No. 2 to survey the damage.

The top terminal had been hit hard by the avalanche coming off the ridge above. The slide had destroyed the motor room and had damaged the bullwheel and the unloading ramp. In addition, one of the lift operators, George Platt, had been buried to his chest. Platt and Wes Hayes, who was the other operator and who had escaped the slide, gave the following account of the accident.

Platt and Hayes were at the top of Chair No. 2 checking out the lift and preparing for the day's operation. Platt had been informed by Butt and Michel that the upper portion of the lift was to remain closed until the snow rangers notified them it was open. They told Platt they would be firing the North Bowl gun and the first round would be fired high so they would have time to get into the motor room for the rest of the firing.

The first round was fired at about 0930, and no slide resulted. Platt and Hayes then left the motor room and were walking toward the lift operator's shack and unloading platform about 50 feet away. At this instant, the second round was fired into Bridger Gully where it released a large avalanche and also caused a secondary release on the ridge directly above the motor room. Hayes saw the avalanche

coming and yelled. He ran ahead of the lift operator's shack and was safe. Platt turned and ran back for the motor room. As he reached the door, the avalanche hit the building, carrying the wooden walls and roof over his head. He said some of the avalanche also passed over him, and he was buried up to his chest in snow. He quickly dug himself out and was not injured. They then phoned the base of the hill and described what had happened.

Avalanche Data

The avalanche that struck the lift terminal was the north flank of a SS-AA-5 avalanche in Bridger Gully. The 2-foot fracture line originated in the gully and came around the ridge above the lift. The main part of the avalanche dropped 1000 feet vertically down Bridger Gully. A total of 13 avalanches were released on the 22nd, all soft slabs of medium-to-large size.

This was a major avalanche cycle at Bridger Bowl during which all slopes avalanched regardless of aspect. This was not slab resulting from wind but rather a uniform slab forming from the graupel and heavily rimed crystals.

Comments

This incident is a good example of critically unstable soft-slab conditions that formed without wind deposition. The new snow that was falling was high density and was in the form of graupel and heavily rimed crystals which formed widespread soft slab. In this case, all slope aspects were equally unstable.

The graupel layer found in the snow pit on the 21st provided an ideal running surface for the slab. Graupel seldom bonds to an old snow surface but rather remains in the pack as a layer of loose pellets resembling BB's. The combination of soft slab and a graupel layer should have been a "red flag" warning the avalanche team to initiate control before conditions worsened.

The ski area was not controlled by artillery on February 20 and 21 because these were the snow ranger's days off and there were no other Forest Service personnel available to perform his duties. To compound the problem, blind firing was not performed at Bridger Bowl at that time. Consequently, even if the snow ranger had been available, the bad weather would have restricted visibility and severely limited any artillery control. Both these weak points in the avalanche safety plan

have been remedied: backup Forest Service personnel are now available and blind firing is now standard practice at Bridger Bowl.

The chairlift that was damaged had been newly installed for the 1967-68 season. Clearly, the location of the top terminal is not safe. More consideration should have been

given to avalanche potential before the chair was built. A splitting wedge or some other type defense structure should be built to protect this lift terminal. Since this accident, further damage to this lift has been prevented by a more complete program of avalanche control.

*1 caught, buried, and killed***Weather Conditions**

The latter half of February 1968 was generally snowy over the central Colorado Rockies. Snows fell daily at most weather reporting sites in Colorado during this period. On the morning of February 24 alone, 10 inches of new snow were recorded at Leadville; also, moderate-to-strong northwest winds were blowing, creating extreme avalanche conditions in the Leadville area. Numerous natural avalanches had recently fallen and were plainly visible to anyone traveling the back country.

Accident Summary

The 15th Annual Leadville Winter Carnival was scheduled for Saturday and Sunday, February 24 and 25. The highlight of the carnival was a 30-mile cross-country snowmobile race planned for Sunday. On Saturday morning, the 24th, a group of five snowmobilers headed west from Leadville to pack the trail for Sunday's big race. They had traveled about 8 miles west of Leadville, going past Turquoise Lake, and were about 1½ miles up the old Carlton Tunnel road when Dean Keas, one of the drivers, had trouble with his machine. Joe Goddard stopped to help; the other three machines continued up the road grade on a steep mountainside.

Shortly, the two men got Keas' machine started, and they then proceeded uphill with Goddard in the lead along the trail broken by the first three vehicles. When the two men were partly up the trail, a small slab released above Goddard sweeping him and his machine off the trail. More snow was dislodged as man and machine tumbled downhill.

The avalanche ran about 100 yards down the slope before coming to a halt. There was no sign of Goddard. His four companions rushed to the rescue but could still find no clues. One of the men then hurried back to Leadville to summon help.

Rescue

At the time the alarm was sounded, scores of persons preparing for the weekend ac-

tivities were on hand to help with rescue efforts. Working with probe poles, the rescuers located the body of Goddard at about 1415. Buried for more than 3 hours under several feet of snow, the victim was dead from suffocation.

This tragedy smothered the spirits of the weekend's festivities. In condolence, the race committee cancelled the race and donated the \$1,500 snowmobile race purse to Goddard's widow.

Avalanche Data

This avalanche was a small slab that was triggered by Goddard's snowmobile. It was but one of dozens that were observed in the area and which ran as the result of the recent snows and strong winds. Further avalanche details are not available.

Comments

This accident documents the first known snowmobile fatality caused by avalanche. The next avalanche-snowmobile fatality was not recorded until December 1970 (see No. 70-8), but as snowmobilers pursue their sport into steeper and more dangerous terrain, the number of accidents can only increase.

One of the clearest signs of avalanche danger is the presence of recent avalanche activity. On their rescue mission, the rescuers noticed numerous small avalanches on the mountains surrounding the accident site. The point to be made here is that back-country travelers should always be watchful for any signs of instability and should be prepared to alter their plans in the interest of safety.

A further note of interest in this accident is that the victim was the fourth person to drive his machine across this slope. The first three had crossed without incident, yet Goddard's machine put the overloading stress on the slope and caused failure. The point to be emphasized is that a single crossing of a slope without failure does not necessarily indicate stability. Too often it is successive passings of snowmobiles or skiers that lead to failure (see No. 65-2 in *The Snowy Torrents* and No. 68-11 in this volume for examples).

2 caught; 1 partly buried, and 1 buried

Weather Conditions

About 12 inches of new snow fell at Mission Ridge on March 14 and 15. High winds accompanied the snow. Because of the bad weather, the upper chairlift did not run on these two days, and no avalanche control was done.

The morning of March 16 brought mostly clear skies and light winds. The low temperature was 28°F and it warmed to 36° by early afternoon. The snow ranger and pro patrol controlled the upper slopes with hand charges and brought down several large hard- and soft-slab avalanches. The upper chairlift was opened at 1010. All areas that had not been opened were posted with avalanche closure signs. Avalanche control teams continued to work areas not open and had to post guards on some of the closed areas because of skiers violating closures.

Accident Summary

At about 1400 on the 16th, Dr. Gordon Congdon, Ray Johnson, Pauline Leedy, and Tom Sawyer, age 14, left the top of Chair 3 and headed for Squilchuck Ridge. Their purpose was to ski some untracked powder snow. To reach their destination they had to climb up about 200 feet vertically during their long traverse. The normal route to Squilchuck Ridge begins at a higher chairlift and was well marked with avalanche closure signs. The group was, therefore, skiing into a closed area but chose a route that took them around the closure signs.

The group reached an open bowl that had not been skied. Johnson entered first, skiing across and then down the fall line. He was followed by Dr. Congdon and Leedy. Sawyer had stopped to rest before entering and was the last to enter the bowl. When he had skied about 200 feet into the bowl, the snow fractured around and high above him. The first three skiers, who by now were near the bottom of the bowl, saw the slide start.

Dr. Congdon skied to the right, out of the

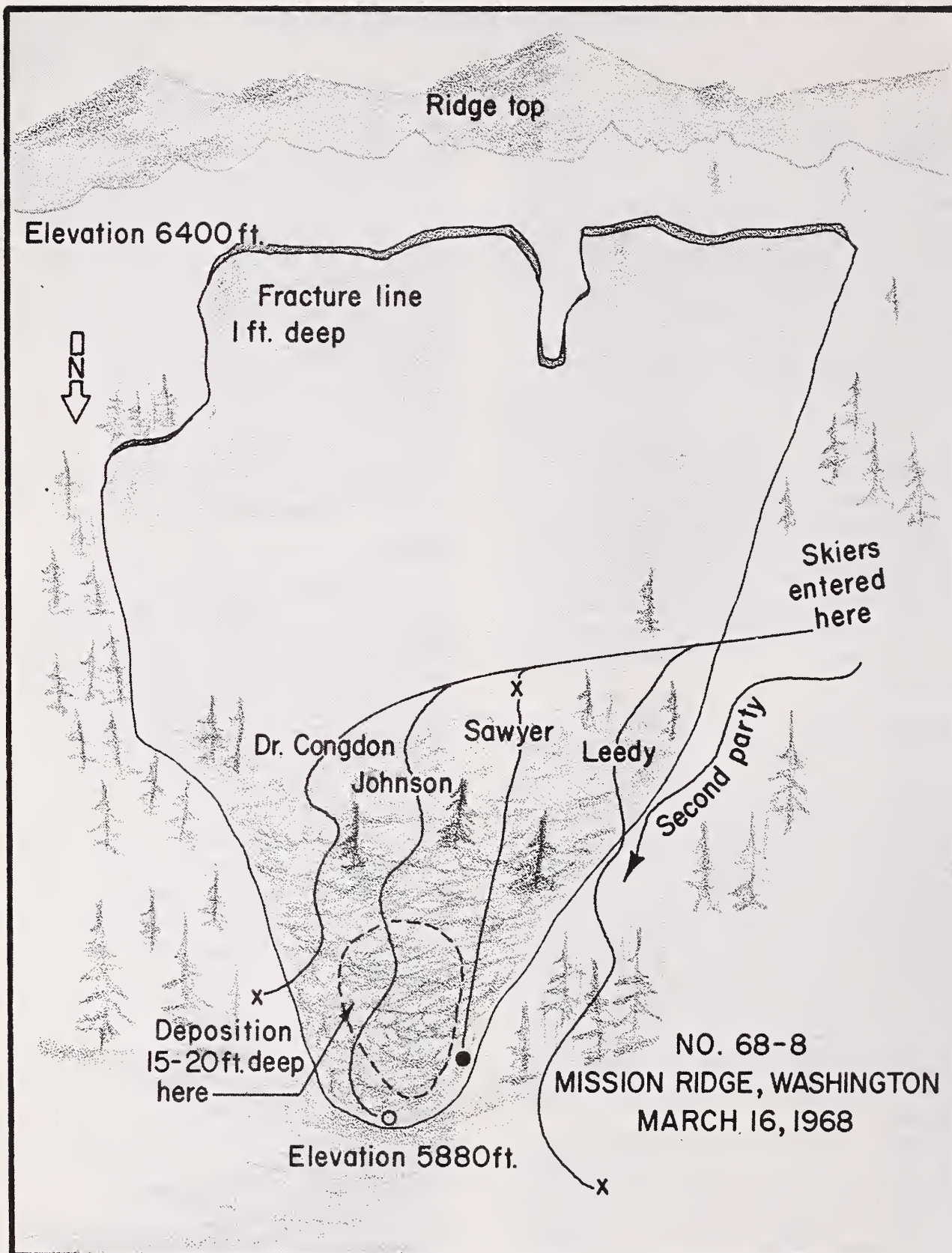
avalanche path, and Leedy skied to the left and down into some timber below the slide path. Johnson skied behind a little knoll at the very bottom of the path thinking that the avalanche would not come that far, and if it did, the knoll would stop it. The slide flowed over the knoll, however, and buried him to his knees, immobilizing him. Meanwhile, the avalanche had knocked Sawyer down, and he was carried down the slope about 400 feet, Dr. Congdon was trying to follow Sawyer's progress in the slide, but the snow was flowing over Sawyer. Just as the slide stopped, Dr. Congdon noticed a black glove flip to the surface.

Rescue

Johnson was closer to where the glove was seen but was unable to free himself quickly from the snow. Dr. Congdon immediately skied around the lower end of the slide and worked his way back up to the glove. He reached the victim in 3 to 5 minutes and frantically began digging him out. Sawyer's hand was the only part of his body that was not buried, and his arm was fully extended toward the surface. His head was about 3 feet beneath the surface. Upon getting Sawyer's arm and head uncovered, Dr. Congdon immediately began mouth-to-nose resuscitation. The victim was unconscious and blue from lack of oxygen.

Meanwhile, another party of skiers, which had been following the tracks of the first, saw the slide start and hurriedly skied toward the avalanche. Dr. Congdon shouted for help and they quickly skied over. One of the members of this group was a professional photographer who shot some excellent photographs to document the rescue effort.

After being freed from the snow, Sawyer quickly began breathing on his own and regained consciousness. He had suffered no injuries in the slide. He had lost one ski pole, but his skies were still intact on his feet. He skied back to the Mission Ridge Lodge with the group, and the slide was reported. The entire rescue had taken little more than 10 minutes.





No. 68-8. Mission Ridge, Washington. This remarkable photograph was taken only minutes after the victim was uncovered. Mouth-to-nose resuscitation has been applied, and the victim has just begun breathing on his own. Minutes later, he was able to ski away under his own power. Photo by Forest & Whitmire Photography, Yakima, Washington.

Avalanche Data

This avalanche was a medium-sized soft slab classified as SS-AS-3. The fracture line was about 1 foot deep and 800 feet long. The slide ran about 1000 feet slope distance, and about 500 feet vertical.

The slope on which the slide occurred was at an elevation of 6200 feet with a north-northwest exposure. The slope angle was 40° in the 200 feet, 33° in the middle 400 feet, and 24° near the bottom with a slight depression at the bottom. The fracture line was on the 40° portion of the slope. Because of the depression at the bottom, debris was as deep as 20 feet in places. Where Sawyer was buried, the debris was 8 feet deep.

Comments

Several of the members of the group that triggered the slide had been previously warned about skiing past closure signs. One member had stated earlier that he thought the Forest Service and ski patrol were wasting time and money on explosives and control work. After the accident, he admitted he was wrong. In this case, the group had not skied past any signs but had known the area was closed. They had climbed uphill from a lower lift to avoid the signs. One member of the second group of skiers, a ski instructor, had also been warned about skiing around closures.

Had the first group not been caught by the slide, the second group might have been the victims.

This accident points to the need of strictly enforcing closures with restrictive measures for violators. Secondly, to improve public relations, demonstrations of control techniques or even invitations to selected individuals to accompany and observe control work might be helpful. This might convince some skeptics of the need for this work.

Very good fortune saved Sawyer's life. He would never have been found in time had one hand not been extended to reach the surface. And after he was found, he was fortunate to have a doctor immediately give resuscitation. Finally, he was fortunate to have been carried outside the deepest deposition area. If he had been more in the center of the slide, he would have been buried in the deepest part of the debris. It is unlikely that any part of him would have remained exposed.

The black glove was the only—and vital—clue that led to quick and successful rescue. In this case, the glove was easily visible, but in other accidents (for example, see *The Snowy Torrents* No. 64-2), clues have been present but barely visible. This underscores the importance of a thorough hasty search for surface clues. Often enough, inexperienced parties have left the scene too quickly to seek help. The buried victim's chance of survival diminishes quickly in these cases.

6 caught; 2 partly buried and 2 buried; 1 killed

Weather Conditions

The first 5 days of March 1968 at Mammoth Mountain Ski Area were clear and mild. Temperatures ranged from the midtwenties at night to the low fifties in the afternoons. On the night of the 5th, an ice crust formed on all exposures, and snow began falling the following day. Ten inches of snow had accumulated when the storm ended on March 7.

Four days of clear, mild weather followed, and it was noticed that surface hoar had formed on north exposures on the upper mountain. Snow began falling on the night of March 12 and totaled 16 inches by the night of the 13th. The weather remained cloudy and cool until the 16th when 8 more inches of snow fell. Sunday, March 17, dawned overcast and cool.

Accident Summary

Avalanche control work began early on the morning of the 17th. A control team of four Mammoth Mt. patrolmen left the top of the gondola and headed west along the ridge locally referred to as the Cornice. Hand charges were thrown in the chutes off the Cornice, releasing several small sluffs. The team had covered $\frac{3}{4}$ of a mile along the Cornice when they arrived at the top of a slope that is now called Scottie's Run. By now they had run out of hand charges and had seen no evidence of major instability. Because there were no clear signs of instability on previous slopes, the group believed Scottie's would be safe also. The four members of the control team skied Scottie's Run without incident, confirming their belief that the snow was stable. (The size and steepness of this slope are such that the patrol would never have ventured upon it had they felt it to be unstable.) When all control teams had finished their work, the upper mountain was opened for skiing at about 1130.

At about 1400, a group of 10 skiers skied west along the Cornice seeking the powder snow on Scottie's Run. The group enjoyed a great powder run and then skied down to the gondola to get in another run on Scottie's.

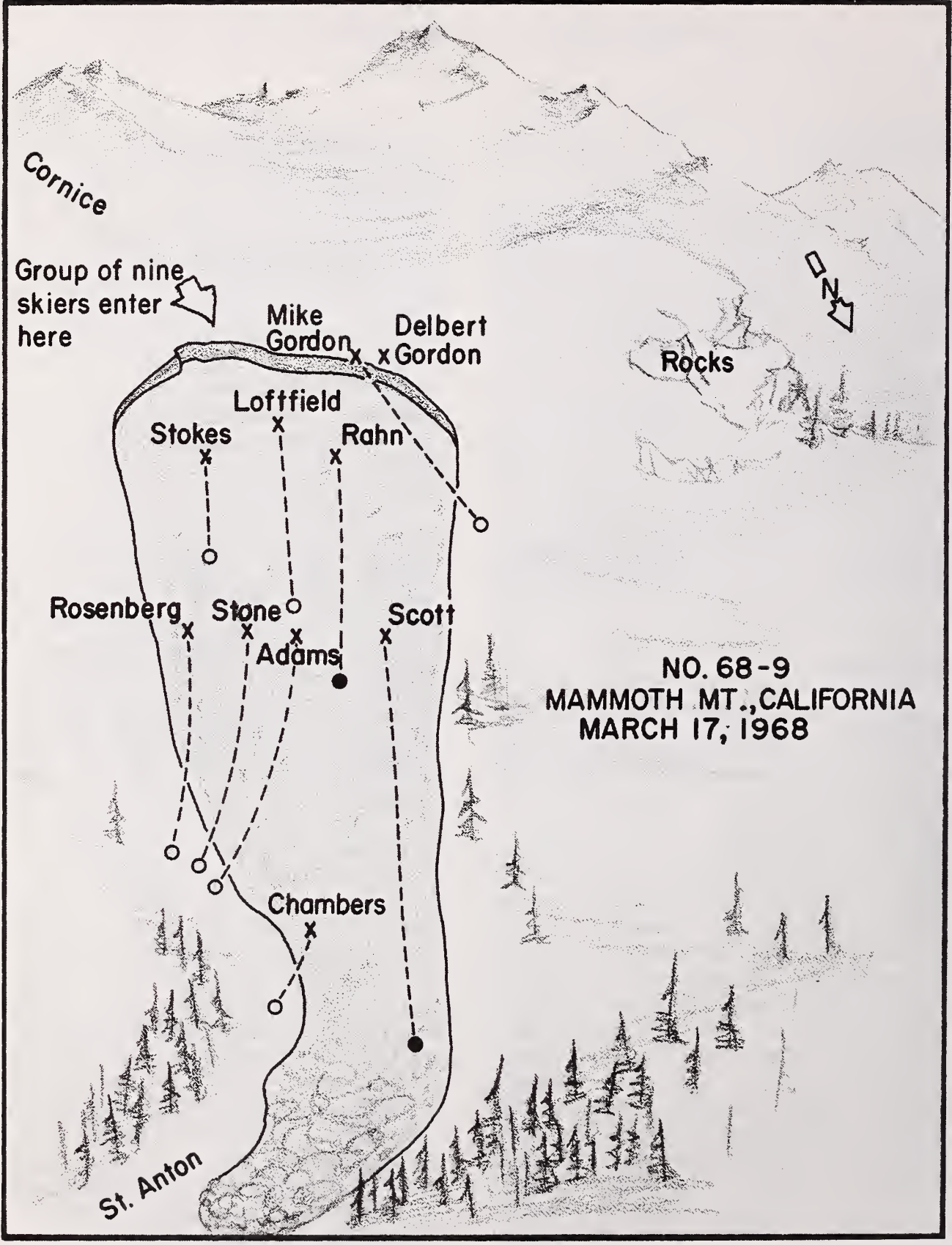
On the next run down shortly after 1500, the group consisted of nine skiers. Four men, including Clifford Scott, skied about two-thirds of the way down Scottie's and stopped. The other five skiers started in at the top of the slope and had skied about one-third of the way down. Delbert Gordon and his son, Mike, were the last members of this group, with Mike slightly behind and below his father. They were both traversing the upper part of the slope when the snow fractured beneath Mike's skis. He was caught but managed to "body surf" to safety on the side of the slide; his father was not caught.

Bob Rahn, who was with the upper group of skiers, heard a sound like a thunder clap and looked uphill to see the avalanche just beginning to move. He was quickly engulfed in the moving snow but managed to stay on top by breast stroking. When he came to a stop he was buried by snow from behind him, but he immediately stuck a ski pole upward and covered his face with the other hand thus creating an air pocket for breathing. He was quickly located by his ski pole and dug out unharmed from beneath 2 feet of snow.

Roger Loftfield also was in the upper group of skiers and was trapped in the center of the slide. He was knocked down and rode the slide on his back, being carried more than 600 feet downhill. He came to rest only partly buried and was able to free himself.

Near the bottom left of the slide path and at the head of St. Anton Gully, another person not with the group, Sally Chambers, had just picked herself up from a fall when she heard someone say, "Oh no!" She turned around just in time to see a wall of snow descending upon her. With no chance to move, she was immediately overwhelmed by moving snow and carried on a 300-foot ride. While immersed in the turbulent snow, she had great difficulty breathing. She came to rest partly buried and was able to dig herself out; she had lost most of her ski equipment.

Meanwhile, the four skiers who had been first down Scottie's were spread out on the lower part of the run. Although no avalanche sounds were heard by this group, one of them



NO. 68-9
MAMMOTH MT., CALIFORNIA
MARCH 17, 1968



No. 68-9. Mammoth Mt., California. Probe lines searching for the victim on St. Anton on March 18. The avalanche flowed from right to left in this photograph.

saw the avalanche and shouted a warning to the others. Three of them managed to get to higher ground, but Clifford Scott was forced into the draw on St. Anton. He was buried under moving snow.

Rescue

After freeing themselves, the group quickly determined that only Scott was missing. One member left the slide area and skied to the bottom to summon help; the other seven began looking for Scott.

Assistant patrol leader, Tom Landauer, was on top of the mountain just after the avalanche occurred and was quickly on the scene. A scuff line made up of available people began searching for clues in the area where Scott was last seen. Meanwhile, at about 1535, the avalanche was reported at the bottom of Chair 3 by two other skiers who had witnessed the slide. The ski patrolman at the top of Chair 3 grabbed the hasty search pack stored there and skied to the accident site. At about the same time, the avalanche was reported to the patrol room at the base area. Snow Ranger Stan Bunce and two patrolmen left by snow cat with a hasty search pack and probe poles. When he arrived, Bunce took over as head of the hasty search.

At 1635, Clifford Scott was found under 4½ feet of snow by the hasty probe line. Mouth-to-mouth resuscitation and external heart massage were given but with no response from the victim. Revival efforts were continued as the victim was transported by snow cat and then by ambulance to the hospital where Scott was pronounced dead from suffocation.

Meanwhile, at the accident site, an unidentified cap was found on the debris and two skiers were reported missing at the bottom of the mountain as the day ended. Because of the chance that more victims may have been buried in the avalanche, the rescue was continued. Probe lines were maintained through the night until 0230 on March 18. At that time, all rescuers were removed because of worsening weather and the threat of another avalanche from the snow remaining at the top of Scottie's.

At 0730 on the 18th, the hanging snow at the top of Scottie's was shot with explosives, releasing a larger avalanche than the one the day before. Probing was continued and then trenching begun in the avalanche debris, but no further victims were found.

The ski area was searched for the two

missing skiers with no results. The back side of the mountain was checked, but wind and new snow had erased all tracks in that area. Finally, at 1730, one of the missing skiers walked into the ski area from the back side; his companion was too tired to walk out and had remained in the canyon bottom outside the ski area. The two had mistakenly skied beyond the ski area boundary, had become lost, and were forced to spend the night in the snow. The other missing skier was shortly retrieved by snow cat.

Also late in the day on the 18th, the ski area received a phone call from a woman identifying the fur cap that had been found in the avalanche debris. When the avalanche occurred, she had been on the St. Anton run and had skied away from the slide. She had not been caught in the avalanche. All missing persons had now been accounted for, and rescue operations were ended at 1815 on March 18.

Avalanche Data

The fatal avalanche was classified as SS-AS-4. It ran 2500 feet slope distance and fell 1000 feet in elevation. The fracture line was approximately 14 inches deep on this north-facing slope, and the avalanche ran on a buried surface-hoar layer. The fracture line occurred about one-third of the way down the slope, lower than its normal release point. Hasty snow pits dug after the accident indicated that the slope fractured where the surface hoar was best developed. The only areas on the mountain that were found to have buried surface hoar were Scottie's and areas to the west along the Cornice.

The fracture line was very straight in the horizontal, and the snow had fractured directly under Mike Gordon's skis. In addition, nine skiers were on the slope at the moment of release, and 10 skiers had skied the slope only a short time earlier. The trigger, therefore, was most likely a combination of the cutting action of ski traversing and the loading and disturbance of nine skiers in the same area. This was enough to cause failure on the weakly bonded surface-hoar layer.

Comments

There is conflicting testimony and evidence concerning whether or not adequate avalanche control measures were carried out on the day of the accident. No explosives were used on Scottie's Run, but hindsight indicates that explosive control should have been

carried out, this being the normal procedure. * The accident and the large slab avalanche released the following morning were dramatic signs of instability, but it cannot be determined whether the instability existed early on the morning of March 17 when avalanche control was being performed or whether it developed later in the day. Certainly, the results of explosive control early on the 17th indicated no widespread instability, for only small sluffs were released along the Cornice. Nevertheless, explosive control should have been carried out on Scottie's because this was standard procedure. The ski patrol felt, however, that the slope was stable, and so they skied it.

The method in which the patrolmen skied Scottie's is another point that was not accurately established. On the one hand, statements were made that the ski patrol had thoroughly protective skied the slope; that is, traversed the slope leaving a criss-cross pat-

* At that time there was no artillery for avalanche control at Mammoth Mt. Now, the standard control procedure is to shoot the entire Cornice area, including Scottie's, with a 75-mm recoilless rifle.

tern. On the other hand, there were statements that protective skiing was inadequately performed before it was opened to the public.

In any event, a lawsuit was filed against the ski area claiming negligence on the part of the ski area by not providing adequate avalanche control measures. The case was settled out of court, and thus, no judgment was ever made on the question of negligence. It would have been a difficult case to decide mainly because there are so many unanswered questions on snowpack stability and the effectiveness of avalanche control measures—questions that stump even the so-called "avalanche experts." Even explosive control has proven to be inadequate in certain cases when avalanches released under skiers on slopes that had previously been hand charged (see Nos. 71-13, 71-22, and 71-23 for several examples). To further complicate the problem, slopes that were stable at the time of control can become unstable later as stress in the snowpack increases with time. These are difficult problems that can only be solved after years of observation, experimentation, and research.

*1 caught and partly buried***Weather Conditions**

Forty inches of snow fell at Stevens Pass from March 24 to 30. The greatest 24-hour snowfall was 19 inches on the 28th; 10 avalanches were released on that day. Strong west and southwest winds averaged 13 m.p.h. for the storm period. (At this time, the anemometer was in a sheltered location; true windspeeds were considerably stronger.) Temperatures ranged from 27° to 34°F.

On the morning of March 30, 4 inches of new snow lay on the ground and the temperature was 22°F. The sky was clear. By 0900, all avalanche control measures including 13 rounds with the 105-mm recoilless rifle had been accomplished, and all areas were opened. Five size 1 and six size 2 to 4 avalanches had been released.

Accident Summary

At about 1235 on March 30, Dick Swanson and Al Holcomb, both from Seattle, had just unloaded from the Seventh Heaven Chairlift and were traversing across Barrier Bowl below Cowboy Mountain. Swanson was about 50 feet ahead of Holcomb when he looked uphill and saw a swirl of snow descending toward him. For a moment, he thought it was another skier but then realized it was an avalanche. The snow struck Swanson, knocked him down, and tumbled him downhill for 100 feet. The avalanche continued for another 100 feet below Swanson before stopping.

Holcomb managed to stop just short of the slide; he tried to keep his eyes on Swanson but lost sight of him for about 30 seconds in the swirling snow dust. When the snow settled, he saw Swanson was partially buried about 100 feet downhill. He called down to see if he was injured, and Swanson answered that he was all right but might need help to get out. One arm and shoulder and his head were free. After being freed from the snow, Swanson and Holcomb skied to the bottom of the mountain and reported the slide.

Rescue

Meanwhile, a chairlift operator at the top of Chair 4 also witnessed the slide and notified the ski patrol by radio. Because it was not immediately known how many victims were involved, rescue operations were initiated. A hasty party of seven patrolmen was dispatched to the scene, and a few minutes later Swanson and Holcomb arrived at the ski patrol office. Holcomb gave his account of the slide and stated that, as far as he knew, only Swanson was involved in the slide.

Just to be sure, it was decided to follow through with the search operation. A main party of 13 probers was sent to the slide site where they probed the entire area; nothing was found. The search was discontinued at 1600.

Avalanche Data

This was a small soft-slab avalanche released by a falling cornice (SS-AO-2) on the ridge of Barrier Mountain (actually Cowboy Mountain). The slide was 50 to 100 feet wide and ran 600 feet slope distance. Barrier Bowl is a northeast-facing slope with an average pitch of 30°. On the morning of the 30th, a SS-AA-4 was released from this slope. The slide that buried Swanson was apparently on the east edge of the larger slide released earlier in the day.

On March 31, a control team climbed to the ridge top of Barrier Mountain to remove the overhanging cornice. Footprints were found leading along the cornice, and at a point directly above the avalanche area, the cornice had been broken off. Evidently, two or more people had been hiking along the narrow ridge top and had broken off a soft cornice which in turn triggered the avalanche that caught Swanson.

Comments

The points of access leading to this ridge have since been posted with avalanche closure signs to prevent a recurrence of this type of accident.

*1 caught and partly buried***Weather Conditions**

On December 4, a light rain fell over Mt. Hood Meadows and formed a rain crust. On the 7th, snow began falling and by 0700 on the 8th, 12 inches of new snow had accumulated. The temperature was 29°F, and the wind was from the southwest averaging 15 m.p.h. but gusting to much higher speeds. Lee slopes were loading heavily from wind-transported snow; 26 inches of new snow had accumulated on the north-facing Elevator Shaft slope.

Accident Summary

At about 0945 on December 8, Richard Eggebraaten and Ralph Stading left the top of Lift 1 and skied a run called the Elevator Shaft. Eggebraaten watched Stading and several others ski down, and then he started down. He made one turn and fell, and one of his skis came off. As he was putting on his ski, another skier, Greg Chamberlin, came down above him. Chamberlin made two turns above where Eggebraaten had fallen and then skied off to the right side of the slope. Suddenly the snow fractured just behind the tails of Chamberlin's skis. He made it to the side of the slope, clear of the moving snow. Stading, at the bottom of the slope, saw the slope fracture and shouted "Avalanche!" He then headed for high ground.

The snow fractured all around Eggebraaten who was standing in the center of the slope. He was immediately knocked down and engulfed by snow. Witnesses caught glimpses of him as he bobbed up and down with the avalanche. He held his hands and poles over his head as best he could but was being buried deeper as he approached the bottom of the slope. When the slide stopped, Eggebraaten was buried to the neck with only his head and arms out of the snow.

Rescue

Eggebraaten was the only skier caught in

the slide, and he immediately called out for help when the snow stopped. Stading quickly skied to his aid. Another witness who was at the top of the slope and not far from the Lift 1 terminal also called for help; within minutes, two ski patrolmen skied down to help dig Eggebraaten out. He was unhurt and had not lost any equipment. The rescue was concluded at 1000.

Avalanche Data

This was a SS-AS-3 avalanche. The slide was measured to be 267 feet wide at the top, 84 feet wide at the bottom, and 253 feet long. The fracture line was 26 inches deep and had fractured down to the rain crust which had formed 4 days earlier. Debris was 14 feet deep in places.

The Elevator Shaft slope has a pitch of 40° and has a convex curvature in the starting zone. It is relatively smooth, is free of trees, and has a north exposure. The top is at an elevation of 6600 feet.

Comments

The past avalanche history of this slope is not known, but its steepness, openness, and aspect all indicate that it should present an intermittent hazard. The slope was skied the day before and was ski checked by the patrol on the morning of the accident. Two comments can be made about this.

First, the slope is too large and dangerous to ski check after storms. Hand charging is a much safer method of checking this slope. Second, a slope is not necessarily stable if one or two ski passes fail to release an avalanche. It is not uncommon for the second, fifth, or even twentieth skier entering a slope to release a slide. It is the instability of the slab layer that dictates whether the first or subsequent skiers will create enough stress concentration to cause failure and avalanche release.

*1 caught, buried, and killed***Weather Conditions**

A storm had moved into the Sierras on December 24 bringing snow and strong west winds. The storm intensified on the 26th, and heavy snow fell and continually strong winds blew on the 26th and 27th.

Accident Summary

On December 27, a group of six college students from Carson City, Nevada, home for the Christmas holidays, planned a day of skiing and a downhill cross-country run at Slide Mountain. The group consisted of Pat Glenn, 18; David Heckathorn, 18; Scott Jones, 18, Bill King, 18; Scott Mattheus, 19; and David Ross, 19.

The members of the party arrived at the Mt. Rose Ski Area to ski in the morning. At 1215 they met at the top of the T-Bar lift and left the ski area. The party made a long climbing traverse along the west side of Slide Mountain. After reaching the 9300-foot level at the edge of the timber, they stopped to eat lunch at 1330.

The weather at the time had deteriorated quite rapidly because of a storm intensifying from the west. The wind was estimated at approximately 45 to 50 m.p.h.

After lunch the party planned to ski down the south side of Slide Mountain into Ophir Creek.

At this time the party became separated. Ross had his skis on first after lunch and started out, with King and Jones following moments later. Glenn had trouble with his bindings so Mattheus and Heckathorn stayed to assist. Visibility had become very limited by blowing ground snow.

After skiing down 150 to 200 yards, King and Jones could not see Ross; they decided to wait for the rest of the group. They thought that Ross had done the same in the lee of one of the small rolling ridges. In a few minutes the rest of the party rejoined King and Jones, and they all started down looking for Ross. The snow cover was very thin in some places because of the southern exposure and prevailing

winds on that side of the mountain. Skiing conditions were poor; thus, the party made fairly slow time. As they reached the 8600-foot level, they had not seen any sign of Ross and had begun to call out and look for him. About the same time they skied into what they thought was a small "old" avalanche and did not pay too much attention to it. They had, however, started some fracturing and small slab movement on the steeper slopes but did not connect the two situations.

They continued down to Ophir Creek and still there was no sign of Ross. They thought that he was still ahead of them and that he was going down to Price Lake. They were not too concerned about not seeing any ski tracks: the strong wind and blowing snow were erasing their own tracks within minutes.

When the party arrived at Price Lake at 1500, there was still no sign of Ross. They rested a while at the lake thinking maybe they had passed him along the way. After calling and looking around the solidly frozen lake, they continued down toward U.S. Highway 395.

They reached the highway at 1815 where they were met by David Ross, Sr. Together they conducted a road search which produced nothing. Finally they returned to Carson City and notified the National Ski Patrol and the Washoe County Sheriff's Office.

Rescue

The five boys in the party were closely interrogated by the ski patrol and sheriff's office. The route taken by the group was mapped out, and it was learned that Ross was equipped for an overnight stay if necessary. It was decided to conduct a surface search the following morning with the hopes that Ross had become lost or injured and was spending the night on the mountain.

On Saturday morning, December 28, the search began with 21 patrolmen and 6 volunteer skiers. In addition, the Nevada Search and Rescue group provided several 4-wheel drive vehicles for getting close to the area. Several skimobiles, one snow cat, and two air-

planes were also used. Low clouds limited the air search, but visibility was good for the ground search.

The route of the ski party was followed but no tracks or clues were found. The one avalanche along the route and near the place where the boys had lunch was not probed. No surface clues were found in the avalanche debris.

The surface search was continued on Sunday the 29th. The rescue leader still felt there was a chance of survival so a larger area was covered, and a helicopter was added to aid the air search. During the night of the 28th, various reports were phoned in: a campfire sighted on Slide Mt. to the north; a light seen on the Slide Mt. avalanche chutes; and smoke seen in Davis Creek Canyon, near the search area. All these were checked out with negative results.

During the course of the search, various rumors began growing that Ross was not with the tour group at all or that he had skied out and left town without telling anyone. The five boys were again questioned, and it was ascertained that Ross was with the group and was most likely still missing on the mountain.

It was decided to continue the search. Fifty-five volunteers searched the area on the 30th and 31st and found nothing. At dusk on the 30th, the helicopter crew reported sighting what they thought was a pair of skis stuck upright in the snow, but this turned out to be an incorrect report. It was finally decided that a "last ditch" probe search of the avalanche debris would be carried out the following day.

On New Year's Day, January 1, 1969, 24 patrolmen assembled at the avalanche site on Slide Mt. Probe lines were begun at 1230. At 1420, one of the probers called the group leader over to check on what he had struck. After making a few probes, the leader thought they had found the missing skier and told them to start digging.

At 1430, David Ross' body was uncovered in the debris. He was found 4 feet beneath the surface, lying on his back with his head uphill. There was a 2-inch-thick ice mask around the face and body. The Washoe County Coroner's report later indicated Ross had died of suffocation and most likely had died within two hours of being buried.

Avalanche Data

The avalanche occurred on the south slope of Slide Mountain at the 8600-foot elevation on a 30° slope and about $\frac{3}{4}$ mile above Price Lake. It was a small slab avalanche that was probably triggered by Ross. Only a thin layer of snow covered the slope; a scattering of low sagebrush and some small willows grew on the slope.

Wind slab had been deposited on an old sun-crust layer. There was little cohesion between the slab and the crust, thus providing a good sliding surface. The depth of the fracture is not known; however, the debris was a maximum of 10 feet deep and averaged between 5 and 6 feet deep. The slide had an estimated length of 300 yards.

Comments

Concern about avalanches was not on the minds of the members of this tour group. The five surviving members gave little thought to the avalanche when they first came upon it. They also showed little concern to the small slabs they released themselves.

A basic rule of safety in ski touring is that the members of the party not lose sight of one another. This party violated this rule and it proved fatal. The slide occurred only a few hundred yards from where the boys had stopped for lunch; however, the site was over a slight ridge and not visible to the others who were a few minutes slower than Ross in getting their skis on. Had Ross remained in sight of the others, there is a chance that he might have been located and dug from the slide in time to save his life.

There was also undue delay in probing the slide site by the rescuers. Even though it would not have saved the victim's life, several days of futile surface searching could have been saved. Viewed from the rescuers' standpoint, the avalanche had crossed a possible route taken by the missing skier; this alone is enough to warrant probing. Even though the rescuers were correct in pursuing the hope that Ross was lost or injured and perhaps still alive, the need for a few hours of probing (for an almost certainly dead avalanche victim) was indicated by the evidence.

2 caught, 1 partly buried

Weather Conditions

Snow began falling in the Bighorn Mountains in north-central Wyoming on January 6. From January 6 to 8, 21 inches of snow fell at Burgess Junction (elevation 8200 feet), located about 30 air miles due west of Sheridan. Heavier snow probably fell in the higher elevations around Medicine Mountain west of Burgess Junction. Temperatures ranged from 38° down to -4°F at Burgess Junction during the storm period.

Accident Summary

Alternate U.S. Highway 14 west of Burgess Junction is closed in winter, but this route over Baldy Pass is popular with snowmobilers. On January 8, three men—Milo Cooper, Ralph Hilton, and Bob Small—were traveling east by snowmobiles approximately along this route. At 1400 they were near the Medicine Mountain Observation Point and were traversing the upper part of a broad slope. Hilton was in the lead, Cooper was about 500 feet behind him, and Small was another 500 feet behind Cooper.

Hilton suddenly felt his snow machine begin to settle as if it were breaking through a crust. He quickly realized, though, that the snow was breaking away from the mountain-side and that he was in an avalanche. An area 800 feet wide had begun to slide!

Hilton gave his machine full throttle and headed for the edge of the slide. His machine suddenly pitched over, but he landed on his feet and scrambled to safety out of the moving snow. Small, who was bringing up the rear, escaped the slide altogether.

Cooper was not so fortunate. He was in the middle of the slope when the avalanche began, and both he and his machine were carried downhill. He was quickly submerged in the moving snow and found it to be very quiet and much like being under water. He remembered from an avalanche school he had once attended that avalanche victims should try to swim with the slide. He began to move his arms and felt his body respond to the swim-

ming strokes as much as it would in water; he was even able to guide himself directionally in the snow. He came to rest just barely covered with snow and was able to dig himself out almost immediately. After being carried about 400 yards, Cooper emerged unhurt from his ordeal. His machine had come to rest above him and was undamaged.

The three men were able to continue their trip, arriving at Bear Lodge near Burgess Junction later that day. They reported the slide and also four more they had seen on the remainder of their journey. Other snowmobile travelers were alerted to the hazard.

Avalanche Data

This large soft-slab avalanche was released by the snow machines cutting across the slope. The slide was 800 feet wide and ran downslope about 1200 feet. Large blocks of snow were left near the top of the slide, but the debris in the runout was well pulverized.

Comments

As the sport of snowmobiling continues to gain popularity, it is reasonable to assume that more snowmobilers will fall victims to avalanches. Their danger is particularly acute because of three basic reasons. First, they are usually traveling in back-country areas that do not receive avalanche control and also do not become packed and stabilized by previous traffic. (Ski areas benefit from both of these stabilizing measures.) Second, the weight of their machines might cause failure on a slope that would be safe to hikers or skiers. Third, once an avalanche occurs, an organized rescue unit is usually too far away to save completely buried victims. If the victim's companions cannot find him, there is little chance of survival.

To minimize these dangers, any group should first of all be well equipped. In addition to standard emergency provisions, avalanche emergency equipment should be included. Several collapsible probe poles and one or more folding shovels are minimum require-

ments. It should go without saying that touring alone is risky business.

Before departing, get the latest weather and snow conditions and plan accordingly. Inform someone of your intended route and estimated time of arrival at some location. Finally, be willing to turn back and abandon the tour if avalanche activity is noted or if other signs indicate hazardous conditions. Observation of recent natural avalanches is one of the best indications of high hazard.

Route finding is very important in a safe tour. Stick to the flats, ridges, or windward

slopes whenever possible. If forced to cross a dangerous-looking slope, cross one at a time. The three men in this accident exercised good judgment by maintaining a distance of 500 feet between them during their traverse. As a result, only one of them was carried away by the avalanche instead of all three.

It is interesting to note the effectiveness with which Cooper said he could swim in the slide. This prevented him from being deeply and helplessly buried in the debris. Swimming is one of the best survival techniques that avalanche victims can use.

*1 house destroyed***Weather Conditions**

The Ketchum vicinity experienced unusually heavy snowfall during January 1969. At the top of Bald Mountain, elevation 8900 feet, and 2 miles south of the avalanche site, 88 inches of snow with about 8 inches water equivalent fell during two major storms between January 8 and 22. During this period, total snow depth in Ketchum, elevation 5800 feet, and 2 miles southwest, increased from 18 to 43 inches. The heaviest precipitation occurred during periods when the temperature was near freezing and included short periods of rain. Snowfall ended on January 22 and was followed by 2 days of very cold weather as temperatures ranged from 6° to -11°F. By the 24th, the snowpack at the avalanche area, a south-facing slope, was relatively dense and hard-surfaced and was about 5 feet deep in the starting zone.

During the night of the 24th, the temperature again fell below zero but snow began to fall as another storm approached. Heavy snowfall accompanied by strong south winds began late on the 25th. By 1100 on the 26th, 16 inches of snow with 1.7 inches water equivalent was recorded on Bald Mountain.

Accident Summary

The Warm Springs subdivision in Ketchum is located on the relatively level river terrace of Warm Springs Creek. The subdivision is bordered on the north by a continuous south-facing slope which rises from 5900 to 7400 feet. The slope has a vegetative cover of sagebrush and grass, and in most winters it has only a thin snowcover or is bare. However, on January 26, 1969, more than 5 feet of snow covered parts of the upper slope.

Rick Borlase's house was located on a small alluvial fan at the mouth of a small drainage of this slope. At 1145 on January 26, an area of snow estimated at 15 acres broke loose from the mountain and avalanched down the draw. The sliding snow struck the center rear of the Borlase house, collapsing the center section and carrying portions 100 feet

downhill. The extreme ends of the house remained relatively intact although they were covered with snow debris estimated at 20 feet deep.

The house was unoccupied at the time except for a dog which was killed. Had it been occupied, the extent of the damage and snow deposition indicate that all occupants would have probably been killed.

Avalanche Data

This avalanche was a SS-N-3 with a vertical fall distance of 500 feet from 6400 to 5900 feet elevation. The slope averages 31°, but is steeper near the top. The fracture line was 1 to 2 feet deep, and an estimated 30,000 cubic yards of snow moved down the slope. Although the flow was nearly stopped when it reached the house, there still was sufficient force to destroy it completely.

The avalanche began with the freshly deposited snow sliding on the hard surface of the old snow, but the sliding snow dug through this surface and carried some of the old snow with it. During the period from 1100 to 1300 on the 26th many other soft-slab avalanches were released from adjacent steep slopes, but none of these reached the runout zone.

Comments

The Borlase house was not the only one threatened by destruction. Local U.S. Forest Service personnel estimated that about 25 houses were in potentially dangerous locations. (Since 1969, more homes have been built in the hazard area.) After the Borlase house was destroyed, the Forest Service advised many families to evacuate their homes; but because the houses were on private land, the Forest Service had no authority to require evacuation or to initiate avalanche control.

This situation is becoming a problem in many areas of the West as more houses and condominiums are being built in avalanche runout zones. Disasters on the scale of those in the European Alps might be possible in this

country if this trend continues. Avalanche zoning of mountain property is needed to prevent the construction of buildings on threatened tracts of land.

The fact that the avalanching slope in this accident was south-facing in no way makes it less dangerous than a similar north-facing

slope. Large destructive avalanches can occur on steep slopes of any aspect during or after prolonged and intense storms such as this one of January 1969. Snowstorms of such magnitude may occur only once in 10 or 20 years, but the avalanches that result are no less deadly than those that run every winter.

*1 caught and partly buried***Weather Conditions**

Snow began falling in the Front Range of Colorado on January 22. By the morning of the 26th, 19 inches of snow had fallen at Winter Park. A mountaintop wind measuring system on Mines Peak showed that southwest through northwest winds averaged as high as 40 m.p.h. and gusted to over 65 m.p.h. during the period from the 22nd to the 26th.

On the 26th, several feet of fresh snow had accumulated on the lee slopes of Niwot Ridge, located 12 miles north of Winter Park. Snow was still falling in flurries with the temperature holding around 20°F. West-southwest winds averaged about 25 m.p.h. during the day.

Accident Summary

Twenty-six-year-old twin brothers, Darryl and Darvel Lloyd, were students at the University of Colorado and were doing research work for the Institute of Arctic and Alpine Research. On Sunday, January 26, they were hiking back to the research station on Niwot Ridge west of Boulder after visiting a research site on Isabelle Glacier earlier in the day. At about 1600, they were climbing up a rocky ridge until it became too steep and seemingly impossible. Against their better judgment, they decided to cut across a steep, snow-filled chute that was about 50 feet wide.

With no rope for belay, Darvel entered the chute after first instructing Darryl to stay on the side and watch his progress. With his first step, he immediately went into deep, soft snow up to his waist. About a third of the way across, Darvel suddenly felt the snow begin to move! The snow had fractured about 50 feet above him, and he found himself riding atop a large slab. He was carrying an ice axe which was of no use to him now, so he spread-eagled himself on the slab, feet downhill.

Darvel had traveled several hundred feet this way when the slab, having gained considerable speed, began to break apart. He was quickly submerged in the moving snow and tumbled over, head downhill. A few seconds

later, he was rolled over again to a more stable position near the surface with his feet downhill. When the avalanche stopped, he was only partially buried and was able to free himself. Darvel had taken an incredible ride down the whole length (1200 vertical feet) of the narrow chute. He had suffered no broken bones or cuts. His only injuries were a serious bruise on one knee and minor bruises on the other knee and elbow. He was very fortunate that he was not struck by his ice axe which was attached by a strap to his wrist and was flipped about by the moving snow.

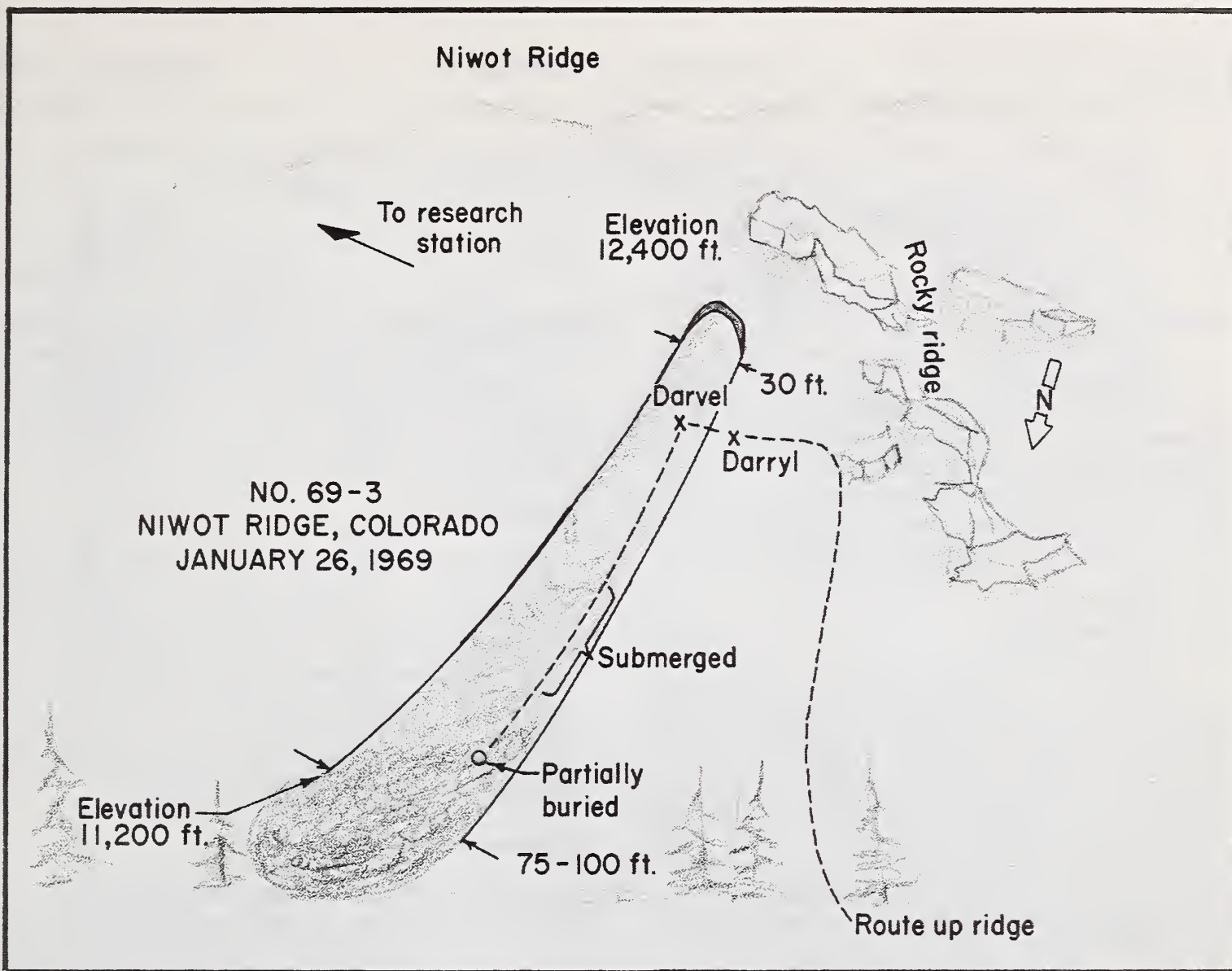
Darryl had started to slide down the cleaned-out chute to help his brother, but Darvel assured him that he was all right. Darvel then climbed back up the ridge, and both men then continued to the ridgetop and then to the research station.

Avalanche Data

This avalanche was classified as SS-AO-4. The fracture line was 2 to 3 feet deep, was 20 to 30 feet wide, had a zigzag shape, and occurred 50 feet from the top of the chute. The chute itself is a straight, even slope averaging 40°. It is a north-facing gully about 20 feet wide at the very top and 75 to 100 feet wide at the bottom. It lies entirely above timberline, starting at an elevation of 12,400 feet and ending at 11,200 feet. The avalanche slid on an old snow surface in the top half of the track and dug down to the ground in the lower half. This being a high-elevation, north-facing chute, it is very likely that depth hoar had developed earlier in the winter, contributing to the instability of the slab.

Comments

Crossing this chute without a belay was unwise, and both men, having mountaineering experience, knew it. They decided to gamble, and they lost. Climbing rope should have been included in their emergency gear. When faced with crossing a snow-filled chute, mountaineers first should be on belay and second should cross as high as possible. Thus, if the



avalanche is triggered, most of the sliding snow will be below the victim. This is desirable for two reasons: first, less strain will be

put on the belay; and second, should the belay fail, the victim stands a smaller chance of a deep burial.

*1 caught and partly buried***Weather Conditions**

On January 24 and 25, light snow fell over the Crystal Mountain Ski Area with a total of 5 inches being recorded. Southwest winds averaging 23 m.p.h. but gusting to 35 m.p.h. blew during this period. Ski checking and hand charging on Saturday the 25th produced a lot of fracturing and settling in place but no avalanching.

Accident Summary

On Sunday, January 26, four members of the Crystal Mt. patrol had skied to the Angle Ridge-Paradise Rocks area to blast a cornice and hand charge and ski check several chutes. The control team had blown a section of the cornice which in turn had released a small soft slab on the slope below. At about 1100, one patrolman, Dieter Oberbichler, skied under the remaining portion of the overhanging cornice to determine where the next cornice shots should be placed. He had done this many times before and did not consider this to be an unsafe practice. The slope was fairly wide at this point and not overly steep, about 27°; Oberbichler believed he could ski out of any small slide that might release. He removed his pole straps but left his ski safety straps attached.

When Oberbichler was about 20 feet below the cornice and on an area of the slope that had not slid, the snow fractured near the base of the cornice. The sudden release took him by surprise and knocked him off his feet. He had no chance to ski out of the slide and was swept downhill on top of the sliding snow. At a point where the slope funnels into a narrow chute, he was carried over the brink of a steep transition and into the chute. He hurtled down this 60° chute and skimmed over the tops of several small trees. Where the slope abruptly levels out at the bottom of the chute, Oberbichler came to rest in an almost standing position, buried to the neck.

The three other members of the control team skied down to Oberbichler's aid and dug him out in 15 minutes. He was still grip-

ping his ski poles; his skis had come off but were still attached to his feet by safety straps. He had been battered by his windmilling skis but had sustained no serious injuries. Oberbichler skied away from this accident only slightly the worse for wear.

Avalanche Data

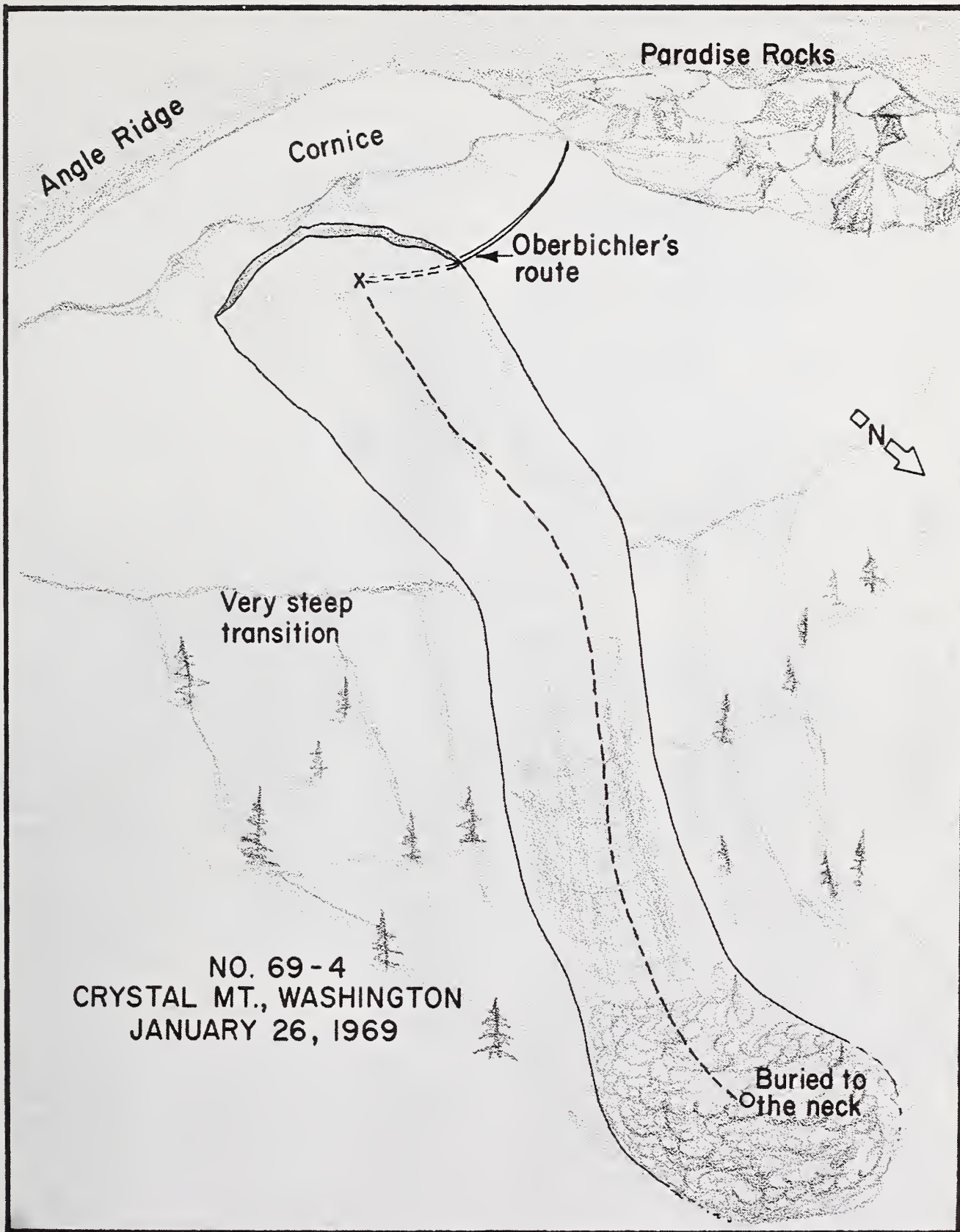
This avalanche was classified as SS-AS-2, fracturing 1 foot deep along a 75-foot-wide front. This was a northeast-facing slope that had been loaded by snow transported by strong southwest winds. The starting zone was a broad area having a steepness of 27°, but the middle track funneled into an ultra-steep chute of 60°. The small soft slab avalanche ran 400 feet vertically down this chute.

Comments

This accident reveals the capricious nature of many avalanche paths. Although Oberbichler had skied beneath this cornice numerous times before without incident, this time the slope reacted to his presence. A clue to the slope's instability on this day, however, was the small slab avalanche that released moments earlier under the impact of the falling cornice blocks.

This accident reveals also that an avalanche man, even if he is fully prepared for the slope to fail, can be caught and rendered helpless before being able to react. Oberbichler did not remove his ski safety straps because he wanted to have every opportunity to ski out of any avalanche that might release. The slope was broad, open, and not too steep, and he felt confident he could ski out of any trouble. Yet he was caught unprepared (Oberbichler later said he was looking downhill the instant the slab fractured above him) and carried on a harrowing ride that could easily have proved injurious.

Avalanche work is dangerous enough without taking unnecessary risks. Oberbichler should have been on belay, a safety precaution that should be observed whenever an avalanche worker skis onto a slope that could produce a long downhill ride.



*1 caught and buried***Weather Conditions**

Through December 1968, snowfall at Loveland Basin had been slightly better than half of normal. Temperatures had been cold and the winds strong during this period, and an extensive underlying layer of depth hoar had formed on all north-facing slopes. On January 22, 1969, a major storm moved into the area (same storm as in No. 69-3). By the morning of the 27th, 35 inches of snow having 2.5 inches of water equivalent had fallen at Loveland Basin. Twelve inches of this fell during the night of the 26th. The morning of the 27th brought light wind and snow and a temperature of 4°F which warmed to 24° by afternoon.

Accident Summary

Before opening Chair Lift 1 to skiers on Monday the 27th, protective skiing was carried out on Upper and Lower Tiger's Tail, Busy Gully, and Cat's Meow—the steep, popular runs served by this chair. The snow on these runs was judged to be stable. Avalanche Bowl and Zoom ski runs were not opened because there had not been time enough to test ski them.

At about 0955, five skiers, including Mrs. Ann Eberle, left the top of the chair and headed for Busy Gully to ski the powder. The group came to the top of the trail; three of them entered the run, made several turns, and stopped part way down. Then Eberle skied down and traversed along the tracks of the earlier skiers. The fifth skier skied down past her.

As Eberle was traversing to her right, the snow fractured 100 feet uphill from her in the trees above the ski run. She screamed when the avalanche hit her. The other skiers in the group instantly looked uphill, but she was almost immediately lost from sight. She was the only skier caught in the slide, and when the snow stopped moving there was no sign of her.

Rescue

As soon as the four survivors realized

Eberle was buried in the slide, three of them climbed up to begin probing the debris while the fourth skied to the base area to report the slide. Instructions were also shouted to skiers riding the chairlift immediately overhead to report the slide at the top chair terminal. Two pro patrolmen were skiing within shouting distance of the chair, and the message was relayed to them by the chair riders. They arrived at the accident site only 2 or 3 minutes after the slide. Four others arrived minutes later, and these nine, headed by patrolman Sam Stevenson, formed the initial rescue party.

Probing was begun using ski poles and skis, but within minutes, probe poles from the rescue cache were dropped off the chair. A coarse probe line was set up, and at 1020 one of the probers struck Eberle's body. She was hurriedly dug unconscious from beneath 4 feet of snow; mouth-to-mouth resuscitation was begun immediately. Oxygen, which had been dropped off the chair, was also administered. The victim very shortly began breathing more easily and regained consciousness. She was then put in a toboggan and taken to the patrol room for further treatment. She made a quick recovery.

To make sure there were no more victims buried in the slide, a second probe line was started. After covering the debris with negative results, rescue operations were concluded.

Avalanche Data

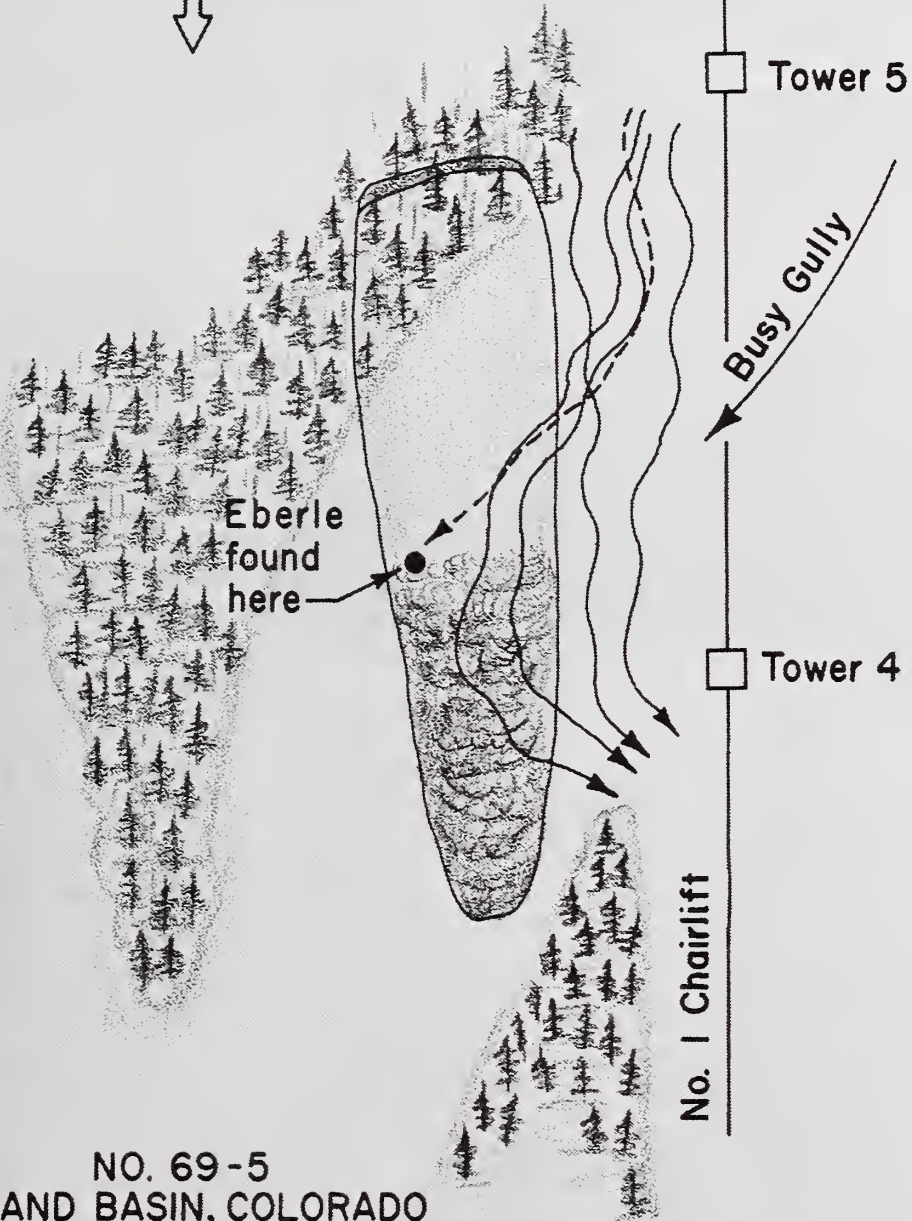
This avalanche was a small soft slab approximately 200 feet long and 50 feet wide. It occurred on a north-facing slope with no record of previous avalanches. The fracture line occurred in a medium stand of spruce and subalpine fir above the Busy Gully ski run.

It cannot be determined whether this slide released naturally or was triggered by the skiers. There is a tendency to feel that the slide was artificially released. However, during the period from 0800 to 1300 on the 27th, five of the Seven Sisters immediately to the east and three areas on the headwall just above the ski area released naturally.

--- Eberle's tracks
~ Tracks of other skiers



Zoom
↓



NO. 69-5
LOVELAND BASIN, COLORADO
JANUARY 27, 1969

Comments

This accident occurred on the second day of an extensive avalanche cycle in the Front Range. Protective skiing was carried out within the ski area, but no explosives were used. In view of the weather conditions and the amount of new snow, some hand charging was warranted. (After the accident, nine hand

charges were thrown and released one avalanche.)

The accident area had been test skied (the standard procedure) shortly before the accident, and the slope had been opened. Nevertheless, it is important for skiers to realize that the best avalanche control methods are not 100% foolproof, as shown by this accident. Fortunately, a quick rescue prevented a fatality.

*3 houses damaged***Weather Conditions**

Weather records from the top of Vail Ski Area, 6 miles north of Redcliff, showed that 51 inches of snow fell from January 23 to 29. Temperatures during this period ranged from 9° to 28°F. Winds from the west and southwest prevailed.

Accident Summary

Ufracio Medina, his wife, and eight children had gone to bed early on the night of January 29. Snow continued to fall, and the temperature was near zero. At about 2130, the snow on the mountainside behind Medina's small frame house broke away and slid down the slope. The snow poured through the back door, around the house, and over the roof.

Minutes after the slide, the town marshall rushed to the house which was now buried

under 10 feet of snow. When he arrived, he awakened the entire family that had incredibly slept through the whole episode! The house had held together, and no one had been injured.

A tunnel was shoveled out to the front door and the family evacuated. Two other houses were hit, but no injuries resulted.

Comments

Few details are available on this accident. The type of avalanche, the steepness of the slope, and the length of the slide are not known, but the slide must have been coming to rest when it struck the house. A fast moving avalanche would have demolished the frame house. As it happened, the snow knocked in the back door and poured into an unoccupied room. This lucky family had a very close call!

*2 caught, 1 buried***Accident Summary**

On the morning of January 30, 17-year-old Greg Hendrick and two friends, Dan and Steve Minnich, went to a steep-walled canyon near their homes to play on and dig tunnels in the snowdrifts there. After digging in the snow, the boys then decided to slide down the steep slope on their backs. It was about 1130 when Greg slid about halfway down the 100-foot incline and waited there in the snow, watching Steve zoom toward him.

Steve had stopped and stood up just uphill of Greg when a 150-foot-wide slab of snow broke loose from the slope above them. Before the two boys had a chance to move, the clubbing impact of the avalanche hit them and sent them hurtling toward the canyon's narrow bottom. Racing spread-eagled down the slope, Greg struggled helplessly as what he thought was just a small snowslide sped him toward the opposite wall of the canyon which angled up in a sharp "V". He slammed against the opposite wall, the snow surging up the bank and settling over him and the canyon bottom.

Meanwhile, Steve was having the ride of his life. He had landed on a large slab of snow which he rode to the bottom. Looking directly down on his friend, Steve watched as Greg disappeared beneath the snow. When the slide stopped, Steve remained on top and could see no sign of his friend.

Rescue

Steve dug frantically in the snow at the spot where he had last seen Greg. Realizing that his efforts were gaining little, he scrambled to the crest of the hill where his brother Dan, because of a strong wind blowing, had not heard the avalanche and was unaware of the accident. The brothers grabbed the shovels that had been used in their tunnel digging and ran down the canyon's slope.

Under the snow, Greg was unaware even of which direction was up. Completely weighted down by the snow, the only movement he could make was to wiggle a few fingers. At first he thought he may have been covered by

only a few inches of snow. He quickly realized, however, that he must be much deeper: his lungs screamed for air as the pressing snow allowed no room for chest expansion.

From somewhere he heard the muffled voice and footsteps of Steve. He shouted hoping the noise would give Steve an idea of his location. His efforts went unheard, and his hopes dimmed when the sound of footsteps faded as Steve went back up the hill to get his brother.

Shortly before 1130 at the Hendrick home, his mother suggested to her husband that he go check on the boys. Not accustomed to checking up on them like that, Howard Hendrick at first demurred but finally consented. He began walking toward the canyon and at one time thought about returning home for a better pair of boots. He arrived at the canyon's brink about 2 minutes after the avalanche. He saw what had happened, scrambled down the hillside, took a shovel, and began digging hard. Steve's first digging attempts with his hands had marked the spot where Greg was last seen, and this seemed the best place to start digging.

Underneath the snow, Greg had given up his yelling to save the little energy he had left. He had given up any hope of being found alive and began wondering how long it would be before his body would be found. A pounding headache and acute shortness of breath were his only physical pains; then a gentle numbness began to settle over him.

Suddenly his father's shovel struck him on the right cheekbone! He instantly sensed the fresh air and was able to breathe again. It took another 15 minutes to clear the rest of the snow from him and pull him free. He had been buried on his back in a contorted position under 4½ feet of snow. He had been buried only about 6 minutes, but to Greg it seemed much longer.

Comments

Except for a series of fortunate coincidences, Greg would have died in this small soft-slab avalanche. First, Steve was able to

mark almost the exact spot of burial; second, the shovels were right on the spot; and finally, Howard Hendrick arrived on the scene almost immediately. Greg concluded that the worst part of the nightmare was the utter helplessness he experienced. The snow was so heavy on top of him that he could do nothing to help himself: he could only wait to be rescued or to die. Good luck was on his side.

While buried beneath the snow, Greg was

able to hear Steve's voice and footsteps, yet his own shouts for help went unheard. This one-way phenomenon of the propagation of sound waves through a snowpack is well-documented by numerous avalanche victims but is not well understood and deserves investigation. In one case, not even four revolver shots fired by a man buried in an avalanche were heard by the rescuers!

1 caught, buried, and injured; 1 house destroyed

Weather Conditions

During the last 3 weeks of January 1969, the temperature in the Pinehurst area of northern Idaho had never reached above the freezing point. Snow had fallen almost daily during this period, and strong winds had been blowing. About 2 feet of new snow fell on January 30 and 31. Snow continued to fall on February 1, and on the 2nd, rain began falling with the snow as a warming trend began. Precipitation had stopped by February 3.

Accident Summary

The home of Mr. and Mrs. Richard Buckham, an elderly couple in their seventies, was located about a mile up Pine Creek from Pinehurst. The one-year-old house was one of about half a dozen located on the flat and at the toe of a steep slope. The Buckham's house sat at the mouth of a small draw in the hillside.

At about 0830 on February 3, the snow fractured just below the ridge and descended the narrow draw which was sparsely covered with brush and trees. The avalanche struck the Buckham's house with great force, cutting it in half. Part of the house was knocked 40 feet off its foundation and demolished; a side bedroom was left standing.

Mr. and Mrs. Buckham were in the house when the avalanche struck. Mr. Buckham was in the bedroom that remained standing and was unhurt; Mrs. Buckham was in the other part of the house and was buried under the broken walls and boards which were covered by about 3 feet of avalanche snow.

Rescue

Neighbors heard the slide as it hit the house and acted immediately. The Pinehurst fire hall was telephoned, and the call was relayed to the Kellogg Fire Department. The Kellogg firemen arrived at the scene at 0855 and organized the rescuers who were already there.

Snow was shoveled from the wreckage,

and pieces of the house were removed as they were uncovered. A trench was begun through the center of the debris, and at about 0930 one of the rescuers yelled that he saw something. Some gray could be seen, and the snow was quickly cleared away from Mrs. Buckham's face. She had snow in her mouth, and as soon as this was removed she exclaimed "Oh, my God!"

Mrs. Buckham had been found under 3 feet of snow, but two plywood doors had fallen on top of her forming an air space about 1 foot high. Her face was buried in the snow and her body was firmly pinned down. She said she could hear the rescuers digging and talking but could not yell because her mouth was filled with snow. She had never lost consciousness but was suffering from shock and a badly fractured left leg. A chain saw was needed to cut the timbers pinning her legs down. She was then rushed by ambulance to the Kellogg hospital for treatment.

Avalanche Data

This was a natural soft-slab avalanche that released in a small bowl in the lee of the ridge. A small cornice had built on the ridge line. The slide was confined to the draw and was about 50 feet wide when it emerged at the bottom. It traveled an estimated 300 feet down the slope. The houses on both sides of the Buckham's narrowly escaped the slide.

This avalanche path has a slope angle of about 33°. The starting zone is mostly free of tree cover, but several trees and bushes grow in the track. Even though this avalanche had sufficient force to destroy a house, none of the trees in the path were taken out because of their small cross-sectional area.

Comments

This house survived only 1 year after being built in the runout zone of an avalanche. Some houses last longer; some, not so long. None, however, would have been built if avalanche zoning laws had been in effect.



No. 69-8. Pinehurst, Idaho. The wreckage of the Buckham house between two neighbors' houses which were undamaged. The location of the victim is marked. The entire avalanche path is visible behind the wreckage.

*3 caught and partly buried***Weather Conditions**

On February 8 to 10, 30 inches of snow fell at Paradise before turning to rain on the afternoon of the 10th. Late on the 11th, the rain turned back to snow, and intermittent snow fell through the 13th. On the morning of the 14th, the wind was calm, and the temperature was 26°F. The recent snowfall brought the depth of snow on the ground at Paradise to 250 inches.

Accident Summary

Three park rangers—Pete Hart, Lee Henkle, and Roy Sanborn—left the Paradise Ranger Station on the morning of February 14 and climbed toward Camp Muir which is perched at the 10,000-foot level on Mount Rainier. They were traveling on snowshoes and were taking the summer trail route. They began ascending the very steep slope beneath Panorama Point, crossing at an area of least avalanche hazard because of the short slope and flat runout.

At 0905 the party was traversing up the slope and had come about 60 feet up from the base when the snow fractured on a wide front 50 feet above them. All three were hit by the avalanche and swept to the bottom of the slope. Each man was buried to the chest and was able to dig himself out. No injuries resulted.

Avalanche Data

This avalanche was a SS-AO-3 triggered by three men on snowshoes. The fracture line varied from 1 to 3 feet deep and was 200 feet wide; the slide fell a vertical distance of approximately 100 feet. The sliding surface was a ¼-inch-thick ice layer.

This slope, lying at the 6400-foot elevation on the south side of Mount Rainier, has a southwest exposure and is a known avalanche path. It has a steepness of 42° to 50° and is open except for a few patches of alpine fir along the top.

Comments

All three rangers were experienced mountaineers and had training in avalanche forecasting and control. Their assessment of the accident was that they had underestimated the sliding potential of this slope; it had been climbed many times before without incident and it did not appear dangerous at first inspection. Of the possible routes to Camp Muir, this one was the least hazardous because of the short exposure to risk. In retrospect, the group should have (1) removed their snowshoes and walked directly up the slope, (2) exposed only one man to the hazard at a time, and (3) used their avalanche cords.

*5 caught, 2 injured***Accident Summary**

On the morning of February 21, avalanche control was carried out with the lower 75-mm recoilless rifle before Mt. Alyeska Ski Area was opened. This resulted in three size 4 avalanches and one size 5. At the end of the ski day, more control work was done from the upper gun above the chairlift. Snow Ranger Chuck O'Leary began firing at 1600. The first shell on Center Ridge caused no release. Convinced that the ridge should release, O'Leary aimed at another fracture zone on Center Ridge and brought down a large part of the ridge (SS-AA-3).

The next shot was fired at 1612 in the Palisades area above and behind Center Ridge. In the past when this area released, the avalanche ran behind Center Ridge stopping in a transition zone, or if large, ran down onto a second transition in the Silvertip area. When the 75-mm shell hit in the Upper Left Palisades, a fracture line shot across three other areas—Alyeska Chute, Sunspots, and Alyeska Peak—for a combined width of nearly a mile.

The avalanche that resulted traveled down the mountain at terrific speed. It overran the first transition behind Center Ridge and then zoomed across Silvertip, the second transition. Here it turned and dropped down and across the Main Bowl trail and into the Canyon. The dust cloud that developed was 400 to 500 feet high.

When the avalanche dropped into the Canyon, the effects of either a devastating air blast or an air-borne powder avalanche were seen. Although the canyon wall on the Racing Trail side is over 200 feet high, the powder avalanche tore out 100 trees from 8 to 20 feet tall that screened the trail from the Canyon. Skiing down the Racing Trail at this time were four patrolmen on sweep and one recreational skier. The airblast struck them, knocking them off their skis and rolling and tumbling

them about 50 feet. One patrolman suffered a cut nose and another a sprained knee.

The avalanche continued down the Canyon and spilled out onto the Racing Trail leaving 3 feet of debris on the trail. The slide came to a stop 500 feet short of the base area, but the dust cloud completely covered and a strong wind buffeted the base area, sending relaxing skiers running for cover.

Avalanche Data

This frightening avalanche was classified as SS-AA-5-G-J; the G indicates that the avalanche ran to the ground in the starting zone and the J indicates airblast. The fracture line averaged 4 feet in depth and was a mile long. The avalanche had a vertical drop of 3400 feet and traveled a distance of 2¼ miles.

Comments

This was the first time that an artificially released avalanche in the upper area had overrun the transitions and reached the lower ski area. A complete revision of safety procedures was begun following this avalanche. Snow Ranger O'Leary said this was the largest and most violent avalanche that he had ever witnessed at the ski area. Even the two large avalanches released during the 1964 Good Friday Earthquake were dwarfed by comparison.

The destructive airblast that accompanied this avalanche occurs only with very large avalanches and can reach amazingly forceful proportions. In a documented case near Berthoud Pass, Colorado in 1964, a 7000-pound dump truck and two heavy attachments for a tractor were carried 65 feet horizontally and 50 feet downhill by what was assumed to be the airblast from a fast-moving avalanche. Amazingly, the truck landed on its wheels and not so much as a window had been broken!



No. 69-10. Mt. Alyeska, Alaska.

2 caught, 1 killed; 2 cabins damaged

Weather Conditions

In anticipation of developing Mineral King into a major ski area, several residents were staying at the area through the winter. Weather records were being kept, but these were lost in the avalanche accident. The winter of 1968-69 was, however, a severe one with very heavy snowfalls. A storm raged over the weekend of February 22 and 23 with 5 feet of new snow being reported on the 22nd, bringing the total snow depth to 17 feet.

Accident Summary

On February 17, two Forest Service employees arrived at Mineral King for avalanche control with the 75-mm recoilless rifle. Empire Mt. and Juniper Ridge were shot with no avalanche releases. The residents expressed concern about snow depths, loads on roofs, and the diminishing supply of propane and fuel. On February 21, two residents left Mineral King under orders from the Walt Disney project manager. Two men, Wally Ballenger and Randy Kletka, remained at Mineral King. A Disney employee, Ballenger wanted to finish the monthly weather report; Kletka, not employed by Disney, decided to stay also. For safety, the two men decided to stay in separate cabins.

At 1800 on February 24, an avalanche just missed the cabin in which Kletka was staying, although some snow had hit the cabin without damage. Kletka radioed the Forest Dispatcher and asked that arrangements be made to evacuate both men the next day or as soon as possible.

A few minutes later, Ballenger was talking to Kletka on the intercabin telephone when a large avalanche came down, crushing the side of Ballenger's cabin and cutting the telephone line. Ballenger dug an air hole from the back door upward about 8 feet to the surface and then retired for the night. He had no further communication with Kletka and did not know that another avalanche had struck Kletka's cabin, caving in the west end and trapping him inside.

Rescue

At 0800 on the 25th, the Forest Service tried to contact Mineral King by radio and got no answer. In the early afternoon, an airplane was sent to view the area, but bad weather prevented the pilot from seeing the ground. The pilot did, however, make radio contact with Ballenger, who said he was all right and could get out of his cabin but he had no knowledge of Kletka's situation. Rescue plans were made for the following morning.

The rescuers assembled at Three Rivers, and the first group was flown in by helicopter shortly after 0900. Two rescuers were deposited near Ballinger's cabin where they could see a pair of skis and a red flag stuck in the snow. They walked to this marker, found the tunnel leading down into the cabin, and found Ballenger safe inside.

They then walked to the general location of the cabin occupied by Kletka. The snow surface was mostly level and undisturbed, and the rescuers had great difficulty in even finding the cabin. A natural hole in the snow revealed the roof of the village store, and from this they were able to estimate the location of Kletka's cabin.

More rescuers arrived by helicopter, and they helped dig and probe for the cabin. At 1130 they hit the roof of the cabin under 12 feet of snow. The spot was above the bathroom, and they chopped through the roof. The bathroom was free of snow, but the adjacent bedroom was caved in so they were unable to reach the rest of the cabin. When they chopped through the roof there was evidence of a fire and the strong odor of smoke in the cabin.

More rescuers arrived by helicopter and helped dig a second hole 14 feet deep before hitting the living room roof. The living room was caved in, and there was evidence of fire. They moved over slightly and chopped through the roof over the kitchen, which was free of snow. The rescuers dropped through this hole into the kitchen at 1415. There they found Kletka's body by the open kitchen door; he had died of asphyxiation. Several cats and dogs in the cabin had also died of asphyxiation.

As the rescuers reconstructed events, Kletka had started to dig out from the kitchen door but was overcome by smoke. The fire had not been intense but had consumed much of the oxygen in the buried cabin. The fire started from a pot-belly stove in a corner of the living room. Kletka could not have reached the fire from the kitchen because of the debris from the collapsed living room roof.

The rescuers could only guess at what had happened, but there was evidence that Kletka had packed a knapsack before starting to dig, apparently not recognizing the danger of asphyxiation. Had he started digging out immediately, he might have made it. He had a snow shovel and a flashlight and had plenty of room in the cabin to shovel snow into as he tunneled. However, he had dug only a few feet before being overcome.

Comments

There is no previous record of such snow depths in Mineral King nor of avalanches running as far as the store and cabin areas. This accident provides ample evidence that cabins built in the runout of avalanches may be safe in normal winters but are decidedly unsafe in heavy-snowfall winters. In this case, the valley was narrow, and the rescuers were not even certain from which side of the valley the killer avalanche came. This cabin was threatened from two directions!

The only defense against such extreme conditions is immediate evacuation. The men should have left the area on their own following the first close call.

3 caught; 2 buried and killed; 1 house destroyed; 1 water tank destroyed

Weather Conditions

Record snows had fallen in the mountains west of Las Vegas. (This was the same storm that dumped heavy snow on Mineral King in No. 69-11.) In places, snow depths were 643% above average on February 25. Around 11,919-foot Mt. Charleston, 50 inches of new snow had fallen on top of the existing snow-pack. The temperature was in the twenties and light winds were blowing. On the morning of the 25th, the Clark County Sheriff's Office closed the Kyle Canyon road to all persons except homeowners. Snowplows were unable to cope with the record snow; roads were impassable.

Accident Summary

Homeowners in Kyle Canyon reported that many roofs were starting to sag and began requesting help. At 1000 on February 25, evacuation operations began with the rangers and sheriff personnel hauling people from the subdivision by weasel and on foot. The Kyle Canyon Fire Station was used as a base for the operation. At 1600, Mrs. Pierczynski called in saying she was quite nervous and wanted assistance in leaving home. She was at home with her 9-year-old son and 11-month-old baby. Rescuers immediately started for her home in a weasel, but the vehicle became buried in the snow, forcing them to turn back.

At 1730 a report came in to the fire station that an avalanche had run across the highway a quarter of a mile above the station. A fireman, a sheriff's deputy, and Mr. Pierczynski, who was returning from work and had just arrived at the station, left the fire station on foot to check on the slide and on Mr. Pierczynski's house. When they reached the slide area, they saw that it had squarely hit the Pierczynski house. The two-story house had been knocked completely off its basement foundation and broken into several sections which were carried 150 feet down the avalanche path.

The three men climbed up from the road

and began looking through the wreckage for signs of the three occupants. The baby's crib was found on top of the wreckage under a sheet of plywood. Miraculously, they found the baby still in the crib, wrapped in a blanket, and sound asleep! However, a further search revealed no trace of the mother and the 9-year-old boy.

Rescue

The deputy returned to the fire station with the baby and called the Sheriff's Search and Rescue Squad; this unit then assumed command of the rescue effort. Later that night, the National Ski Patrol was called, and at 2200, six patrolmen from nearby Lee Canyon Ski Area began probing the debris. By 0200 the next morning, the area from the house to the toe of the debris had been probed but no clues were found. The work was slow and tiresome as many uncertain objects were felt by the probers and these had to be checked out by digging down through 10 feet of wet snow.

At dawn on the 26th, a D-8 cat arrived and began removing debris. At 0815 one of the family's dogs was found alive under a portion of the roof. At 1415 a second dog was found crushed in the wreckage. A few minutes later the bodies of Mrs. Pierczynski and her son were found; both had been crushed to death by heavy house beams.

Avalanche Data

This large avalanche was a natural soft slab that released just below a vertical cliff at the 8000-foot elevation on the south side of Mt. Charleston. The slide was about $\frac{3}{4}$ mile long and ran down a slope that was brush covered but had been stripped of timber in a fire about 15 years before. There is no record of this slope sliding in the last 30 years.

A contributing factor in the complete destruction of this house was a water tank located 200 yards behind and above the house. This tank contained 100,000 gallons of water and was hit by the avalanche. This explains the

wet snow found by the rescuers.

There were about 20 other slides in the Mt. Charleston area within a 24-hour period. Considerable damage was done to two Forest Service campgrounds, and two other unoccupied homes were destroyed. A total of 26 house roofs collapsed under the snow load.

Comments

This was a rare storm that brought heavy snows to southern Nevada, and the avalanche paths responded. Although this slope had not avalanched for at least 30 years, when it did run it was deadly.

People who insist on building houses in hazardous areas, whether they are aware of the hazard or not, must be willing to evacuate their homes during periods of heavy snowfall. Two homeowners evacuated in time; for Mrs. Pierczynski and her son, evacuation efforts came too late.

This was the fifth accident in less than a month involving homes built in avalanche paths (see also Nos. 69-2, 69-6, 69-8 and 69-11); two resulted in fatalities. As the reader shall see, this volume contains several more such accidents, most of which could have been prevented by zoning restrictions.

*1 caught and buried***Weather Conditions**

About 18 inches of snow had recently fallen at Bear Valley. By early afternoon on March 1, the sun was shining brightly, and the temperature was in the thirties.

Accident Summary

At about 1300 on March 1, the lower lift at Bear Valley was opened. Bill Heyenbruch was skiing the powder alone on the runs served by this chair and had already released a small soft slab but was not caught in it. He then released a second small avalanche on a short slope and fell. The flowing snow quickly engulfed him, and he found himself gasping for air. His skis did not release and it felt as though they were dragging him under. He began swimming motions with his arms, but the slide slowed to a stop before the swimming had much effect.

Heyenbruch was completely buried, lying on his back. The layer of snow was thin, and he was able to sit up and clear snow from his face.

It took another several minutes to dig himself out and locate his poles. He was uninjured but was out of breath and very cold. He continued to ski and had one more slide release beneath his skis.

Avalanche Data

The avalanche that caught Heyenbruch and the other two he released were all classified as SS-AS-1. Fracture lines varied from 1 to 1½ feet deep, and none of the slides ran much more than 50 feet. At least one other slide was released by another skier that afternoon.

Comments

A minimum of information is available for this accident. However, no fewer than four small soft-slab avalanches were released by skiers this day; thus, it is evident that snow conditions were unstable. The victim violated a cardinal rule by skiing alone; he was fortunate to have been only lightly buried.

2 caught; 1 partly buried and injured

Weather Conditions

Until March 4, almost no snow had fallen at Alpental since February 13 when a sizable storm came to an end. Light snow began to fall on the morning of March 4 and intensified during the day. By the morning of the 5th, 14 inches of new snow containing 1.42 inches of water equivalent had fallen at the study plot at the base area; 18 inches of new snow covered the upper mountain. The snow fell on a firm crust which had formed and persisted during the previous 2 weeks. Southwest winds of 10 to 20 m.p.h. blew while the storm was in progress.

Accident Data

Shortly after 0800 on March 5, pro patrolmen Doug Rouraback and John Kubiack left the top of Chair 2 at the summit of Alpental to run their avalanche route. The area's avalauncher was temporarily buried in a snow-drift, forcing the patrol to hand charge several chutes of the International area from above. To reach the top of International chute 1, it is necessary to traverse around the summit of Denny Mt., the highest point in the ski area. This traverse takes the control team across an open face on the southeast flank of Denny Mt. This face is normally shot with a 75-mm recoilless rifle; however, on this day the face was closed to skiing because of bad weather and small crowds. Hence, no gun control was effected.

The two patrolmen left the chairlift and began a climb directly up the ridge toward Denny Mt. Rouraback skied over to the edge and hand-charged chute 3 of International, while Kubiack started across the open, southeast-facing slope toward the opposite (west) ridge. On his traverse, Kubiack triggered a small soft-slab avalanche that released above him and carried him 75 feet to the flat below; he was buried to the waist. He was able to dig himself out and climbed back up to join Rouraback.

The two men continued their traverse but came to a stop beside a small group of trees.

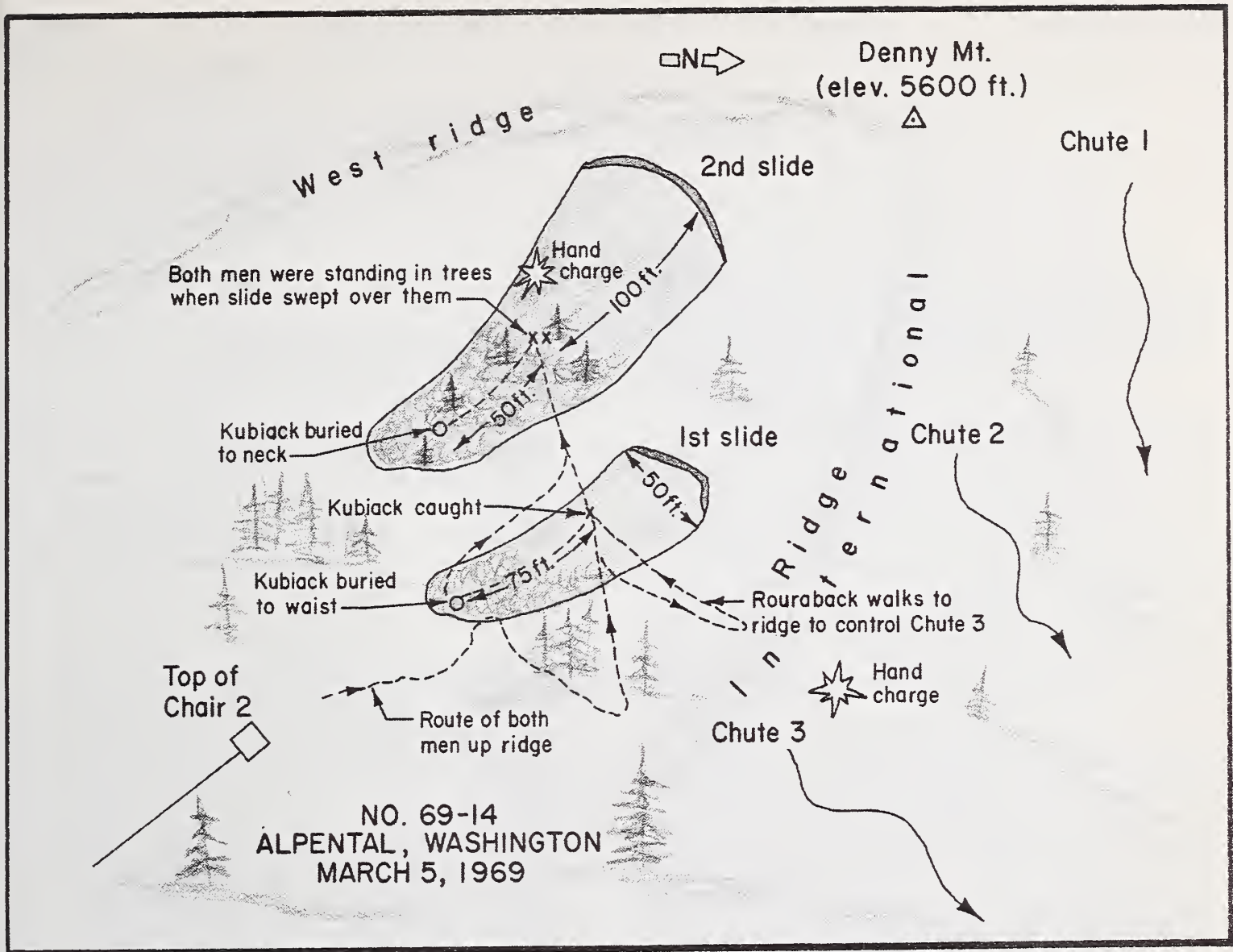
Before attaining the west ridge, they had to cross a heavily loaded slope in the lee of the ridge. Kubiack threw a charge onto this slope, and both men anchored themselves against the trees.

The charge released a shallow soft-slab avalanche which fractured 100 feet above the shot point and above the two patrolmen. The avalanche flowed down over both men; Rouraback managed to hold tight, but Kubiack was unable to hold his position and was swept downhill. When Rouraback was able to see again, Kubiack was nowhere in sight. Rouraback skied down and found his partner's hat on top of the snow. A few minutes later he found Kubiack mostly buried in a small island of trees. Kubiack had been carried 50 feet and was lying on his side with only his head sticking out of the snow. One ski binding had been broken when he hit the trees, and he complained of chest pains, later diagnosed as torn cartilage. He was able to make it back to the top of Chair 2 under his own power where he caught a ride to the base area. Rouraback completed the avalanche route without further incident.

Avalanche Data

The first slide that caught Kubiack was classified as SS-AS-1. It fractured 1 foot deep and 50 feet across and ran a little more than 100 feet slope distance. The second avalanche was a SS-AE-2, fracturing only 6 inches deep but across a broad front. It ran about 200 feet down the slope. Both slides occurred on the open slope on the southeast side of Denny Mt. above the top terminal of Chair 2. The slope is very steep in the starting zone—45° or steeper—and slides frequently. It especially reacts to either heavy snows or west or southwest winds.

March 5 was a high-hazard day at Alpental: almost every path that was shot ran. All three of the International chutes ran, with fracture lines averaging 18 inches in depth and falling as much as 900 feet vertically. This instability was within the new snow layer, with the hard crust providing a good bed surface.



Comments

This accident was caused by not heeding the warning signs that indicated a very touchy situation. Many avalanches were running in the area, and Kubiack had already triggered and been caught in one small slide. After the hand charge was thrown, the two patrolmen

should have retreated to a point of greater safety.

The route across this slope is a dangerous one. The steepness and lack of cover make traversing, and even hand charging, this slope very risky business. It should be crossed only after being shot with the 75-mm rifle.

*1 caught, buried, and killed***Weather Conditions**

Light snow fell at Paradise, Mount Rainier from March 3 to 8 with a total accumulation of 29 inches, bringing the total depth at Paradise Ranger Station to 250 inches. On the night of March 8, a strong east wind began blowing. Windspeed varied from 40 to 70 m.p.h., and west-facing slopes were heavily loaded by wind-blown snow. The morning of March 9 broke clear, cold and windy.

Accident Summary

John Aigars, age 31, left Seattle at 0500 on the 9th for a ski tour to Camp Muir, located at the 10,000-foot level on the south side of Mt. Rainier. He parked his car in the Paradise parking lot and began his climb alone, not bothering to sign the register. At about 1030, he reached the bottom of Panorama Point and began ascending the slope with climbing skins on his skis. This was a steep southwest-facing slope that was heavily loaded with wind-deposited snow. (This was adjacent to the avalanche slope in No. 69-9.)

Apparently while he was near the middle of the slope, the snow fractured above him. The avalanche knocked Aigars down, carried him to the bottom of the slope, and completely buried him.

Rescue

At 1800, Aigars' car was the only one left in the Paradise parking lot. The park ranger checked the sign-out register and found no unaccounted-for parties. When the car was still there at 2000, the license number was checked through the state patrol to find the owner's name. Aigars' parents were soon located. They told the park ranger that their son had planned a one-day trip to Camp Muir and still had not returned; he was long overdue.

At 2200, two park rangers boarded a snow cat and drove to the base of Panorama Point to check an avalanche that had been reported earlier in the day. The weather was still clear and cold, but 50 to 70 m.p.h. winds were caus-

ing heavy blowing snow. The avalanche debris was checked, revealing no clues. Because of the poor visibility and high avalanche danger, it was decided to delay further rescue attempts until daylight.

At 0700 on March 10, an aerial reconnaissance flight was begun to cover the Muir Snowfield and adjacent areas. The flight detected no sign of the missing skier. By mid-morning, ground crews were organized, and at noon four rangers were flown to Camp Muir by Air Force helicopter. They worked their way down the Muir Snowfield checking for signs or tracks. Two other rangers arrived by snow cat, but no clues were found by the six searchers.

Earlier in the afternoon, four rangers went to the avalanche area below Panorama Point, searching the debris and checking the perimeter of the slide for tracks. Again, no clues were found. At 1900, four German Shepherd avalanche dogs were brought to the avalanche site. These were from the German Shepherd Search and Rescue Dog Association in Seattle. They worked the area for 3 hours but to no avail.

On the morning of the 11th, another flight was initiated to expand the search area, because of recent information that the missing skier frequently left his planned routes. In addition, three search dogs were again taken to the Panorama Point avalanche site. Two other dogs began working up the east side of the Nisqually Glacier from Glacier Bridge to check avalanche debris in that area. Plans were also made to bring in about 35 probes around noon.

At 1030, one of the avalanche dogs working the Panorama Point avalanche found the body of John Aigars. He was found facing uphill and buried at an angle with his head about 2 feet under the surface and his feet about 5 feet under. The snow was so tightly packed around his body that he had obviously been unable to move at all. There was no ice mask around his nose and mouth, indicating that suffocation was probably very rapid after burial. His pack, poles and skis were still attached to his body, and climbing skins were on



No. 69-15. Panorama Point, Mt. Rainier, Washington. View of the Panorama Point avalanche showing the victim's probable location when caught (O) and location where the body was found (X). This photograph was taken 2 days after the accident; most of the fracture line at the top of the slope has filled in with wind-blown snow. National Park Service Photo.

his skis, indicating that he most likely triggered the slide while ascending the slope.

Avalanche Data

This was a medium to large avalanche on a wide and fairly short slope. It was classified as SS-AS-3 or SS-AS-4. The slide was about 200 feet long and 400 yards wide. All but a short section of the fracture line had been filled with wind-blown snow when it was observed; this section of the fracture line was estimated at 6 to 8 feet deep.

This slope has a steepness of about 45° and had been heavily loaded in the starting zone with wind-deposited snow. The slope faces southwest and was therefore in the lee of the strong east wind that was blowing. The instability of the slab was shown by the great length of the fracture line.

Comments

The victim violated two basic rules of ski touring by traveling alone and by not signing out at the Ranger Station. A companion—if he, too, were not buried in the avalanche—would have given Aigars a chance of survival: the companion could have either effected a res-

cue or summoned help. By signing the register, Aigars would have at least notified the rangers that he was still on the mountain. As a result of this accident and the one on February 14, 1969 (No. 69-9), a blackboard showing current weather and avalanche conditions has been located over the sign-out register at the Paradise Ranger Station.

The rescue operation was very well planned and executed. The overall plan was first to exhaust all alternatives that could have resulted in finding the victim alive and only then to concentrate all efforts on the slides, where he would have certainly been found dead.

The value of avalanche dogs can readily be seen in this rescue. The avalanche debris covered an area approximately 100 by 400 yards. It would have taken 40 men about 8 hours to coarse-probe this area, an expenditure of 320 man-hours. However, several avalanche dogs were employed in 20- to 30-minute shifts and covered the area in about 4 hours. Had the snow been lighter and the victim not been buried so deeply, the dogs would have likely found him within 1 hour. The use of avalanche dogs in the early phases of an avalanche rescue is highly recommended.

4 caught, 1 killed; 2 vehicles damaged

Accident Summary

On Sunday, March 16, John Sellers, age 28, was driving along a logging road 3 miles off State Highway 20 and about 14 miles northeast of Missoula. With him were his wife, Beverly, and two friends, Mr. and Mrs. Charles Hutchins. At a spot where the road parallels the Blackfoot River, a small avalanche slipped down the mountainside above the road and partially buried the car. Only the wheels were buried, but the car was firmly stuck. As the four were attempting to free the car, a fisherman, Dee Cleveland, arrived in his pickup truck and offered his assistance.

Cleveland was unable to push Sellers' car out with his pickup. While the four stranded motorists made further attempts to dig out their car, Cleveland walked a short distance down the road to get some gravel to put under the tires. At this moment, the remaining snow cover broke loose from the mountainside above the unsuspecting victims. The avalanche roared down the slope and struck them and the two vehicles. All four victims, the car, and the pickup were hurled down a 20-foot embankment into the icy waters of the Blackfoot River.

Cleveland came running back up the road and hurried down the embankment. Beverly Sellers and both the Hutchinses were pulled from the river, but John Sellers had disappeared beneath the surface.

Rescue

Later in the day, a diver from Missoula entered the river and found Sellers' body in about 20 feet of water, a victim of drowning. The other three victims were hospitalized for treatment of minor injuries and observation.

Comments

There are numerous incidents of two or more avalanches on the same path over a short period of time. (Another tragic example of this is documented in No. 71-4.) When an avalanche releases below its normal release point, the snow slab above the fracture line is left hanging and undergoes a great increase in tensile stress, thus enhancing the likelihood of a second avalanche. This is a hazard that must be considered by all rescue groups. If the danger from a hanging snow slab seems imminent, control measures must be taken to minimize the risk to rescuers working below.

*1 chairlift damaged***Weather Conditions**

The weather during early April in the Mt. Alyeska region of Alaska had been very unsettled with intermittent rain and snow. Total new snow at the midway station (elevation 1,400 feet) at Mt. Alyeska Ski Area was 26 inches for the period from April 6 to 12. Temperatures at midway remained almost constant during the period, ranging from 30° to 33°F. Precipitation fell as rain from sea level to 500 feet, mixed rain and snow from 500 to 1,500 feet, and snow above 1,500 feet. Therefore, snow amounts were much higher in the starting zones of the avalanches that threatened the ski area than in the midway study plot. Wind action on the new snow was visible on the upper areas when the weather permitted observation. Snow conditions on the upper mountain were becoming increasingly more unstable, but poor visibility prevented the upper gun from being fired at these targets.

Accident Summary

On the morning of April 11, the lower 75-mm recoilless rifle was blind-fired at Max's Mountain because low clouds obscured the mountain. Eight rounds failed to release any snow. The upper gun again was not fired because it was not set up for blind firing. Rain and snow continued until the morning of Saturday, April 12, at which time the skies cleared.

On Saturday morning both the lodge and the ski patrol buildings were cleared of people before firing began. The lower gun released a large hard-slab avalanche on Max's Mountain. It ran fast and dry until it reached the heavy, wet snow at the 1,500-foot elevation; from there it continued as a wet-snow avalanche, digging to the ground. It moved very slowly near the end, finally grinding to a halt 300 feet above No. 3 rope tow.

At 0900, Snow Ranger Chuck O'Leary and his gun crew secured the lower gun and rode the chairlift to the upper 75-mm rifle. The first shot was on Center Ridge and released a large hard-slab avalanche which ran across the

Main Bowl trail. Seven more rounds were fired into the Main Bowl area, releasing two more avalanches in the Shadows. It was now 1030, and the skiers were getting restless. It was decided that although the lift line and Racing Trail areas would be opened for skiing, the Bowl and the trails immediately below it would be kept closed. The Saddle and Shadows on the back side of Max's Mountain would be shot at the end of the day.

Hand charging and test skiing released only one small slide in the rest of the ski area. Many of the skiers fell down repeatedly trying to ski the heavy, wet snow but no problems developed. When the lifts closed at 1630, O'Leary and three others went to the upper gun and prepared for shooting. At 1710 when the all-clear was given by radio from the base area, firing began. Several rounds produced one small slide in the Shadows area.

The gun was then turned to the Saddle where the first two shots failed to release anything. The third shot was put into the upper left side. A large fracture line shot across the top of the Saddle for a distance of 600 feet, setting a major avalanche into motion. It moved very fast down the steep wall, throwing up an enormous dust cloud. The gun crew radioed to the bottom alerting them that a large avalanche had started.

As the avalanche moved across the lower part of Silvertip, the dust cloud began to diminish. The moving snow was now out of sight of the gun crew. The lower radio then called and stated that they had seen the dust cloud settle and everything appeared to be all right. The gun was then turned to the next target, and two more rounds were fired with negative results.

Then the lower radio crackled again saying they had just seen a tree go down in the Canyon. The next minute they excitedly said they saw an enormous mass of snow moving out of the Canyon. The upper gun crew secured the gun, strapped on skis, and headed for the bottom.

Meanwhile, a wall of snow about 25 feet high crept out of the Canyon toward the base terminal, moving more like a mudslide than an



No. 69-17. 1. Mt. Alyeska, Alaska.

avalanche of snow! As the snow advanced, ski area personnel began moving everything that could be moved. A snow cat was hastily driven out of the path of the slowly advancing snow, and others began driving cars out of the parking lot.

The lower terminal of the chairlift was directly in the path of the avalanche. Dozens of people watched helplessly as the snow crushed the lift control building and slowly twisted and bent the steel support columns of the lift terminal. The avalanche then threatened the ticket office. The snow mass crept right to the building, pressed against walls and windows, and stopped without breaking a single pane of glass!

Avalanche Data

This avalanche was classified as HS-AA-5.

It started at an elevation of 3,000 feet and stopped at the 400-foot level, a vertical drop of 2,600 feet. It had run a slope distance of more than $1\frac{1}{2}$ miles. The fracture line was estimated at 600 feet in length and 2 to 6 feet in depth. The steepness of the starting zone was 35° .

Most avalanches releasing in the Saddle stop at the transition at Silvertip where the slope gentles to 10° . The unusual feature of this avalanche is that although it slowed and almost stopped when it hit the heavy, wet snow in the lower bowl area, it still had enough force to gouge out the wet snow and set it in motion. The wet snow then gained enough momentum when it dropped into the Canyon to carry it well past the Canyon mouth. The wet snow mass was about 25 feet high and 100 feet wide and moved so slowly that those rescuing



No. 69-17. 2. Mt. Alyeska, Alaska. The lower chairlift terminal sustained heavy damage from this avalanche. The mass of wet snow was approximately 25 feet deep.

equipment could keep ahead of the snow with a brisk walk.

Comments

This was the second avalanche of the 1968-69 winter that reached the base area from the Main Bowl (see No. 69-10 also). In the previous 10 years only one other avalanche had released from the Bowl and made it as far as even the Canyon. To Snow Ranger O'Leary, this pointed out the need for more constant

control with the upper gun. This gun has now been setup for blind firing to prevent dangerous accumulations of new snow from loading the avalanche starting zones during prolonged periods of poor visibility.

An additional safety factor could be had by building a mound field on the transition directly above the Canyon. These cone-shaped mounds would act to dissipate the force of an avalanche and would retain more snow in this area, keeping it from dropping into the Canyon.

*1 caught and injured***Weather Conditions**

Six days of fine spring weather had reduced the snowpack at Alta from 104 to 84 inches by April 14. Snow began falling on the 14th, and by noon on the 15th, as much as 10 inches of new snow covered the upper mountain. Skies were cloudy on the 15th with fog, light snow, and poor visibility. Avalanche conditions were considered high for the Peruvian Gulch area, and this part of the mountain was closed to all skiing and touring at 0900 on the 15th.

Accident Summary

Terry Steward and Paula Varney had been recently hired by the Alta Lodge, and neither was very familiar with Alta and its ski runs. At about 1330, they left the top terminal of the Wildcat lift and headed down the west slope of Peruvian Gulch on a run known as Hasty Exit. This run was outside the patrolled ski area; the two skiers violated a closure to reach it. Skiers descending this run must negotiate a gap in a cliff band part way down. While skiing above the cliffs south of Hasty Exit, Steward triggered a small avalanche. He was knocked off his feet and then carried over the cliff, falling 80 feet to the rocks below! The avalanche continued down the steep incline below the cliff and carried Steward another 100 yards before coming to a stop.

Varney was not caught in the slide, but she lost sight of her companion as he was swept over the cliff. She decided the slope below was too steep for her to ski, so she took off her skis, left them there, and climbed down the cliffs ending up below Steward. She was unable to see him anywhere. She called out to him but received no answer. Deciding that help was needed immediately, Varney made her way down to the junction of the bypass road to Alta and the main road. She was picked up by Peter Lev, a visiting patrolman from Jackson Hole, who realized the seriousness of the accident and rushed back to Alta. The accident was reported at 1430 to patrol leader Bill Moss who immediately organized a rescue party.

Rescue

Two rescue parties were formed with all available patrolmen. Four men were sent up the Wildcat lift to drop in the top of Peruvian Gulch; four others along with Varney loaded a snow cat with a toboggan, resuscitator, oxygen, splints, and other emergency first aid equipment and headed for the scene. An ambulance was called from Salt Lake City to meet them at the junction of the main road and the bypass road where they would bring the victim out.

The snow cat was unable to reach the victim so the rescuers were forced to carry their equipment in on foot in a tough, uphill climb. Moss was the first to reach Steward's side. He found him on top of the snow in a half lying, half sitting position, conscious but in a bad state of shock and large lacerations on his head which proved to be fractures. He had been bleeding heavily from his head wounds, was coughing up blood, and was bleeding from his ears and one eye. It appeared to Moss that the victim had also suffered several broken bones, but because of Steward's state of shock, Moss was unable to communicate with him to find out what might be broken.

Steward was given first aid to stop the bleeding and was carefully loaded in the toboggan. He was carried downhill to the snow cat and then transported to the road where the ambulance was waiting. He was then taken to a Salt Lake City hospital where he remained in critical condition for several days. Steward's injuries were so severe that he never made a full recovery.

Comments

No matter how small, any avalanche that can sweep its victim over a cliff must be considered treacherous. This avalanche was classified as a SS-AS-2 and would have been harmless had the cliffs not been below. Few skiers enter this area because of the difficult terrain and marginal skiing conditions. Had the two skiers been more familiar with this area, they would have certainly picked another spot for

their tour. On the day of the accident, this area had been closed to skiing because of avalanche hazard.

The rescue was carried out quickly and

competently. Only an hour and fifteen minutes was spent from the time the patrol was notified until the victim was placed in the ambulance. Quick action saved Steward's life.

*1 caught, partly buried, and injured***Weather Conditions**

Crystal Mountain Ski Area had received only very light snowfall during November and early December. The study plot at the base area (elevation 4400 feet) had a total snow depth of only 9 inches on Wednesday, December 10; the ski area was not operating. Snow began falling on the 10th with 3 inches recorded on that day. On the 11th, 18 inches were recorded followed by 4 inches on the 12th. Temperatures remained cold during this period, and very strong west winds were blowing.

On Saturday, December 13, the snow turned to rain as warmer air invaded the region. Rainfall of 0.56 inch was recorded by 0800 on the 13th, and rain continued during the day. The temperature had warmed to 36°F. Several natural, wet loose slides had released on the steeper slopes.

Accident Summary

On the 13th, the upper part of Crystal Mt. was open for skiing. At about 1100, two pro patrolmen, Jerry Johnson and Buzz Franklin, were in the process of hand charging and ski checking the north and west faces of Exterminator, or Green Valley side of Exterminator. This area lies just above the lower terminal of the Green Valley chairlift.

Before controlling one avalanche path along the ridge, the two patrolmen conferred and decided to ski check it. Johnson made the first pass across the starting zone in deep, heavy, wet snow. Franklin then cut a track just below Johnson's. No avalanche released. They again conferred, deciding that Franklin would make another pass across the slope while Johnson skied over to a nearby chute.

Franklin began his second pass, got hung up in the heavy snow, and fell. When he hit the snow, the slope fractured 50 feet uphill and

right along the line of Johnson's first ski pass. Franklin was only partially submerged as he was carried downhill but was swept into a stand of scattered trees. He was using neither pole straps nor ski safety straps, and as he hit the trees his skis and poles were ripped away. He came to rest a short distance below the trees in an almost standing position with only his head and one arm sticking out of the snow.

Johnson, who had witnessed the accident, skied down to help his buried partner. Franklin was freed within minutes, but he complained of severe back pains. He was taken by toboggan to the first aid room and then driven to the Enumclaw hospital. The diagnosis was several depressed or crushed vertebrae. Fortunately, Franklin made a full recovery and was back on skis again later in the winter.

Avalanche Data

This was a medium-size wet-slab avalanche classified as WS-AS-3. Rain or a mixture of rain and snow was falling at the time of the accident.

The fracture line was 3 feet in depth, and only a shallow, hard crust of snow was left covering the ground. This north-facing slope, which lies just below 6300-foot Iceberg Point, has a steepness of approximately 36° in the starting zone. This avalanche ran the full length of its track, falling some 300 feet in elevation and coming to rest in Green Valley.

Comments

This avalanche path is too big and dangerous to be ski checked; it deserves a hand charge. Ski patrolmen need not take undue risks. Additionally, Franklin was skiing without pole straps or ski safety straps, which allowed his equipment to release when he hit the trees. This probably spared him from more extensive injuries.

Iceberg Point (elev. 6300ft.)

Iceberg
Gap

Exterminator
West Face

First ski pass

X Franklin
fell here

Johnson's
track

Franklin
rescued here



Green Valley Ski Run

Green Valley Chairlift



NO. 69-19
CRYSTAL MT., WASHINGTON
DECEMBER 13, 1969

*4 caught***Weather Conditions**

In early December 1969, a shallow snowpack lay over much of the Wasatch Range. A storm moved into the region on December 4 and snow fell daily for nine straight days. By the 12th, 36 inches of new snow had increased the snow depth at Alta from 17 to 39 inches. Temperatures had remained cold, rarely exceeding 20°F at any time until the end of the storm on the 12th. Then the temperature rapidly warmed, reaching a high of 48°F on the afternoon of the 13th. Winds had been strong and from the west on the 9th to the 12th.

Accident Summary

On the morning of December 14, a party of five experienced ski tourers left Alta and proceeded up to Cardiff Pass enroute to Lake Blanche. The group skied down the north side of Cardiff Pass on what appeared to be stable snow and then traversed below the east ridge of Mt. Superior. From this point it is necessary to traverse a broad, open bowl, climbing all the way to reach a saddle on Cardiac Ridge. From this saddle, it would be downhill all the way to Lake Blanche.

As the group began their traverse of the open bowl east of Cardiac Ridge, it became apparent that wind action had produced soft-slab conditions. They continued their climb and reached the final steep section near the ridge crest. In this area the snow had formed a uniform hard slab. The surface was so icy that the main concern of the skiers was to maintain their footing.

When the two skiers in the lead were within 100 yards of the saddle, a wide area of the slope broke loose 50 yards above them. Skiers 1 and 2, who had been highest on the slope, remained on the surface as the snow slid out from beneath them. They were carried on a fast ride but were not buried. Skier 3 was farther downhill and in the center of the slide area. He was hit hard by the avalanche and was tumbled downhill. Although he was buried several times during his ride, he came to rest on top of the snow. Skier 4 was nearer

the edge of the slide and rode it on top of the snow. Skier 5 was below and to the right of the avalanche area and was not involved.

All five skiers were using special ski poles supplied by the International Vanni Eigemann Foundation. These poles have an avalanche cord coiled inside the handle which can be ejected when necessary. In addition, the two poles can be joined together to form a probe pole. Before skier 3 was swept off his feet, he removed his skis and ejected the avalanche cord from one of his ski poles. Fortunately skier 3 came to rest on top of the snow, for his poles, skis, and the entire length of the avalanche cord were buried beneath the snow. It is not known whether any of the other skiers ejected their avalanche cords.

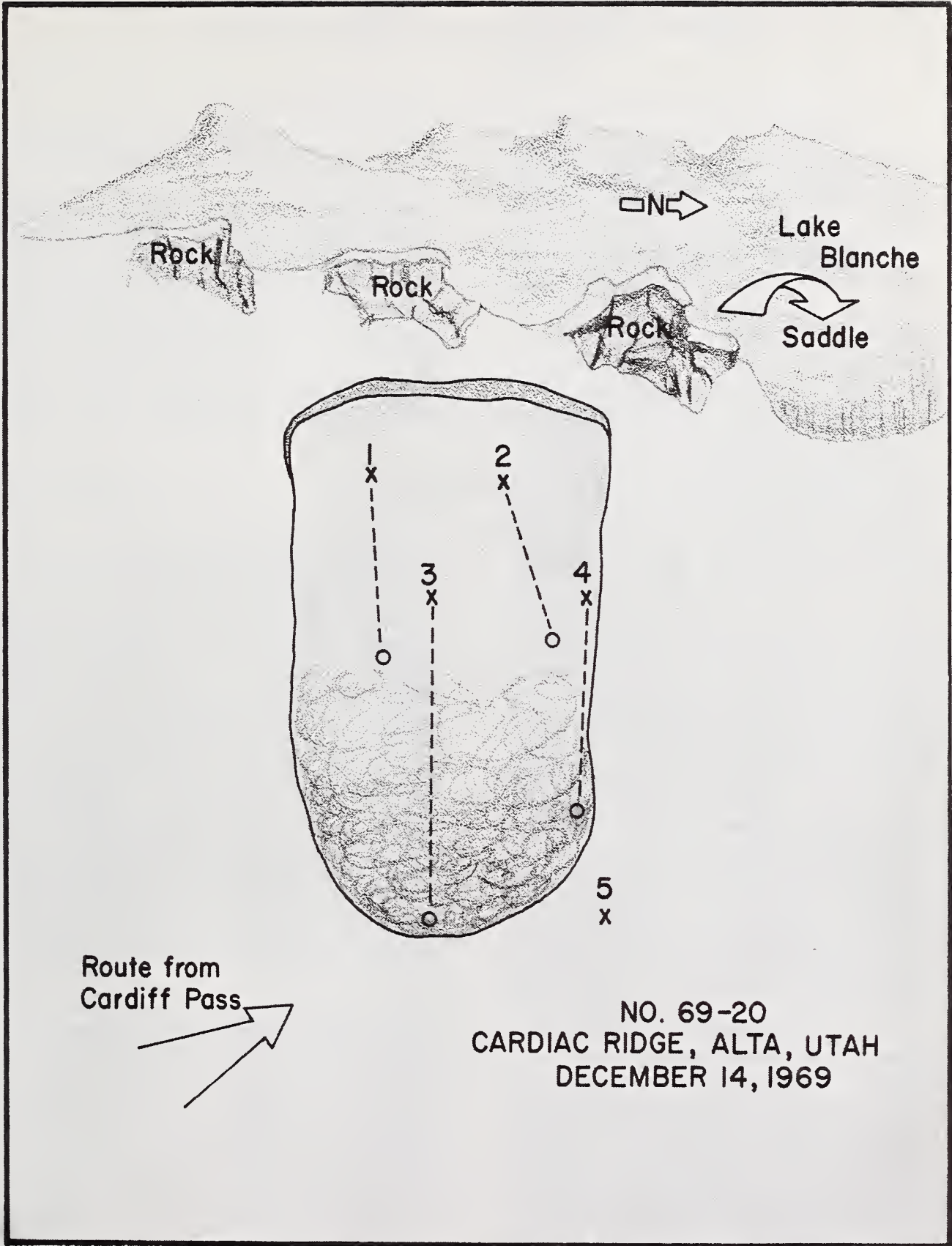
The group probed for the equipment lost by skier 3 and after 45 minutes finally found one ski and both poles. Skier 3 had suffered a twisted knee but still was able to walk out with the rest of the group via Mill D South Fork to the Big Cottonwood Canyon road.

Avalanche Data

This avalanche was classified as HS-AS-3. It ran on a steep, open, east-facing slope and had been formed by the strong west winds of a few days earlier. The fracture line was 2 to 3 feet deep and was about 225 feet in length. The slide ran about 900 feet slope distance and dropped a vertical distance of about 400 feet. A layer of depth hoar lay beneath the hard slab snow making a highly unstable snowpack when supporting four skiers.

Comments

The route taken by these skiers is strictly a high-hazard route. Most of the skiers taking this tour realize the danger but feel the rewards of the tour are worth the risk. However, there have been enough avalanche accidents on this route to make it taboo for the timid or the safety-conscious skier (see *The Snowy Torrents* No. 64-1. Another accident occurred in February of 1972.) There is simply no safe route across the cirque north of Cardiff Pass



and east of Cardiac Ridge.

The buried avalanche cord is a rather disquieting circumstance of the accident. An avalanche cord is of absolutely no use if it is

buried beneath the avalanche debris. Again, this incident and that in No. 67-9 are enough to cast serious doubt on the dependability of avalanche cords.

4 caught; 2 partly buried, and 1 buried; 2 injured

Weather Conditions

Early-season snowfall had been average in the Rockies of Colorado, providing an excellent snowpack for Christmas vacationers at the local ski areas. At Breckenridge, 25 inches of snow fell on December 24 and 25, increasing the total snow depth from 47 to 63 inches. This snowfall contained 1.53 inches of water equivalent, and strong west-to-northwest winds had formed widespread soft-slab conditions.

Accident Summary

A first person account of the day's events is given by Jim Hagemeyer, a Forest Service landscape architect, who was involved in the accident: "On December 25, Christmas Day, I went to Breckenridge to ski with Snow Ranger Dick Shafer. He was out on avalanche control work, and I was unable to contact him until around 1245. At that time he asked me if I would like to accompany him, Al Britt of the N.S.P.S., and one of the ski area's professional patrolmen to look at a fracture line in the closed bowl (Horseshoe Bowl) to the north of the upper poma lift. We all rode up the poma lift then traversed over to the edge of the bowl.

"The bowl is around 1 mile wide and 1 mile long, from top to bottom. Average slope probably is around 32° and all of it offers avalanche hazard.

"Earlier in the morning the patrol had placed two charges in this area and produced a fracture line running the entire width of the bowl. The fracture line varied from 4 to 7 feet high on the far end. The reason for going to look at the fracture was not quite clear to me; however, it seemed that the primary purpose was to check the various snow layers and to see on which layer the avalanche had slid.

"Everyone put on his orange nylon avalanche cord except myself. (Mine, unfortunately, was down at the car.) We traversed out onto the slide area, directly below the 4-foot fracture line. Upon digging down into the snow, we found about 3 feet of crust and depth hoar still remaining in the slide area below the

fracture line. At this time, I mentioned to Dick that it appeared very unstable to me. He reassured me that it had to be stable considering the amount of shooting and the size of the slide. I was still apprehensive about staying there, especially since I was the only one without an avalanche cord.

"The rest of the people had moved out away from me and we were all about 50 feet apart with Rick, the pro patrolman, in the lead; Al was next, then Dick, then myself. I thought I should be going back and turned to look for a safe way out. About this time I heard a sharp sound, like a clap of thunder, similar to a charge going off in the snow. My first reaction was that a charge had been set off, but as I looked upslope, I could see a new fracture line going across the top of the slope and the snow starting to move!

"Since the big load was still above us, there was not an immediate movement of the snow under my skis. I immediately turned my skis downhill into a shuss, thinking that I could reach a rock outcropping and possibly outski the slide. At this time I thought I was the only one caught in the slide.

"I had skied perhaps for a second or two when the major impact of the load above hit me, tossing me into the air and completely engulfing me. At this time I lost my poles and had a terrible feeling of panic. Several thoughts ran through my mind: first, I was a damn fool for coming there; and second, I fully realized the size of the slide and was certain that I would die.

"The feeling was of being dunked under water, as the impact took my breath away. For some reason, when I started to move with the slide, I could breathe much easier. I thought about the fact that I didn't have an avalanche cord and that it was up to me to get myself out of there. My right leg was being bent behind me by the pressure on the ski, which then released. Neither of my arlberg straps had been taken off; I am not really certain that this was a hindrance to me, though this thought occurred to me as I was engulfed in the slide. As it was, I got a good belt on the shins from one of my skis.

"The sensation of speed was fantastic; I had put my skis into a shuss on a 30° slope and was engulfed immediately. I remember the speed increasing as I went down the slope. The ride was very rough, and I was being tossed around quite a bit. It seemed as though I was in a big flume of water, where I was occasionally able to get a breath of air; but most of the time I was overwhelmed by snow.

"Later, individuals asked me if I had a sensation of which way was up or down. I can truthfully say that I was aware of up and down, at least after the initial shock of the slide hitting me. Initially, when the full blast of the slide struck me, I had no idea which way was which. As I moved downhill faster, I was able to orientate myself fairly well with the movement of the snow.

"I worked myself into a sitting position, with my feet downhill, and tried to swim as if treading water. This seemed to work, and I instantly started to rise in the snow. I kept doing this as I sped down the hill and increased the swimming motion as the slide began to slow down a little. Actually, it was not a fast decrease; it was just going very fast, then it started to stop slowly.

"I swam until I could feel the slide coming to a stop. I was still buried at this time. How deep, I didn't know, but it seemed deep! I pulled my arms in near to my head; at that minute the slide came to a rather abrupt halt, and I found my head and hands sticking up out of the snow. The snow was still moving very slightly, and I was able to work my body out to where I was sitting on the surface. I was able to pull my feet out and immediately release my arlberg straps."

Rescue

"My first reaction was that I was the only one caught. Then I turned and looked at the hill, and saw that the entire hillside had come down. I also saw the ski patrolman, Rick, still on his feet. He had been able to ski out of the edge of the slide. I yelled to him several times, asking if there was anyone buried. He finally answered that Al was buried. I ran toward the shouts and found Dick digging himself out. His head was downhill. He said he was okay.

"I then tried to regroup my thoughts, and remember where Al was before the slide took place. Everyone had 50-foot avalanche cords on except me, and we were all spaced fairly evenly apart. (It seemed natural to wait until the other fellow's avalanche cord was out before you started across the snow.) I

remembered that Al was second in line, and started scanning the snow approximately 50 feet away from Dick. Looking uphill, I spotted a piece of orange cord protruding from the snow. I ran to the cord and yelled to Rick, who was then below me, that I had found Al and to go for help.

"I used the cord to pull myself up the snow, to where it disappeared into the snow. I made one swipe with my hand, a little ahead of the cord, knowing it was tied around his waist. The second swipe hit an object, and I was able to dig out Al's head. His head was approximately 14 inches or so below the surface. I continued digging until I got his head fairly free; he was still conscious. Dick arrived at this point and seemed to be okay but complained about his knee hurting him. As it turned out, he had a slight fracture of the lower leg.

"At that time I glanced at my watch, it was 1325. The slide had occurred at approximately 1315; it had taken me about 5 to 7 minutes to get myself out of the slide, find Al, and free his head. Although he was still conscious, he appeared to be going into shock. We continued to dig around Al until the first party arrived about 25 minutes later. Two patrolmen arrived with the toboggan, and three others stood on a rocky ridge where they could act as lookouts and be available to help if they were needed. The patrolmen administered first aid to Al and loaded him in the toboggan.

"Dick and I both had ended up in little gullies at the bottom, while Al was buried on a flat plane, almost a ridge. When I went to retrieve my skis and to ski out of the area, I noticed that the deposit on top of the old slide where my skis were sitting was approximately 10 feet deep. I actually had to climb up onto the ridge of snow to get my skis. I went down to join Dick, because the patrolmen were now handling Al. I started to get real nervous about the snow hanging above us. The patrolmen waiting on the hill continued to yell to us to get out and later asked why we didn't. The reason was that Dick's leg was hurting him, and he felt he could get out a lot easier on skis, in the deep snow, than by walking. But first he had to retrieve one of his skis, which was buried fairly deep. I started out first and met the snow cat, which was coming up to the base of the slide area to pick up Dick and Al (on the toboggan).

"As far as injuries go, I was perfectly okay, though later in the evening and the next morning, I felt as though I had played football all day. Dick had a wrenched knee, which we

later discovered was chipped. Al, other than going into shock, had muscle spasms and a cracked pelvic bone, which was discovered later."

Avalanche Data

The first avalanche had been artificially triggered by hand charges, releasing the entire bowl for a distance of about half a mile. This slide was a SS-AE-4, ran 900 feet vertically, and had a 4- to 7-foot-deep fracture line. The second avalanche was triggered by the skiers, releasing about 200 feet above the first fracture line. This one was a SS-AS-4 with a 4-foot fracture line which extended about 300 feet in length. A thick layer of depth hoar—15 to 30 inches in depth—lay at the ground beneath the slab. The second avalanche dug to the ground in parts of its track. Debris was 10 feet deep in places.

Comments

This accident is very instructive in several ways. First, it points out the danger from a hanging snow slab after an avalanche has released lower on the slope. If there is still plenty of snow above the fracture line, the slab is usually unstable by virtue of having no support from below. It is a situation to be avoided.

It is speculated that the second avalanche was triggered by skiers walking on the bed surface of the first avalanche. Their weight placed enough stress in the slab far uphill to cause failure. In this case, the fracture line should have been inspected by one person at a time, and this person should have been on belay. The weight of the four skiers was more than the slope could support.

Another important point is the effective-

ness of swimming with the slide as reported by Hagemeyer. He swam on his back, head uphill, as though treading water. (However, his skis were still attached so leg movement was hampered.) He was able to swim effectively even though his skis were still dangling from his boots by his arlberg straps. Dick Shafer on the other hand, was knocked forward by the slide and swam on his stomach, head downhill, as though he were doing a breast stroke. Both men were able to maneuver in the snow, putting them less at the mercy of the avalanche. Hagemeyer is strongly convinced that swimming did a lot toward saving his life.

Most important though is that this is the first documented case in which an avalanche victim was saved because of his avalanche cord. Al Britt and all his ski equipment were completely buried, but a section of his avalanche cord was on the surface. The avalanche cord proved its value and worked the way it was intended. This, though, is not always the case, as exemplified by Nos. 67-9 and 69-20. The avalanche cord should be used, but the user should realize it is not 100 percent reliable.

In retrospect, Hagemeyer had some final thoughts on the outcome of this accident: "Looking back on the whole operation we can no doubt say we were extremely fortunate not to have anybody killed. Personally, I feel extremely lucky not to be dead at this time. It was an awful incident, and one which we need not have experienced had we used a little sense. However, it is worthwhile to pass this on to other individuals.

"In conclusion, I might say that it was probably the best Christmas gift I have ever had in my life to end up sitting on top of this slide."

*5 caught, buried, and killed***Accident Summary**

On December 26, 1969, five young climbers contacted Glacier National Park Ranger Robert Frauson at his home at St. Mary on the east side of the park. The five were Jerry Kanzler, 18; James Anderson, 18; Mark Levitan, 20; Clare Pogreba, 22; and Ray Martin, 22. They planned to climb the north face of Mt. Cleveland which, at an elevation of 10,448 feet, is the highest peak in the park.

Frauson, an experienced mountaineer, tried to persuade them not to climb Mt. Cleveland in winter. He mentioned the severe and unpredictable weather conditions, avalanche hazard, and the time required to obtain rescue service should they need help. Frauson failed to dissuade the group from making the climb, but they did agree to climb the west face rather than the more difficult north face.

The five climbers camped overnight at St. Mary and departed early on the 27th for Waterton Townsite in Canada. They hired the services of a Waterton resident to transport them by boat to the south end of Waterton Lake, a trip that carried them back into the United States. From this point, they began a crosscountry hike toward Mt. Cleveland which is located 3 miles to the southwest. This was the last time the five young men were seen alive.

Rescue

On December 31, Bud Anderson, the older brother of James Anderson (one of the climbers), flew over the Waterton and Mt. Cleveland area to check on the location of the five climbers. He saw what he thought were their tracks leading into a fresh avalanche about halfway up the west face of the mountain. Also, other tracks appeared to leave the avalanche site, but he was not certain of this latter observation. Anderson figured that the climbers should be able to complete their climb, barring an avalanche misfortune, by the following day, January 1, 1970.

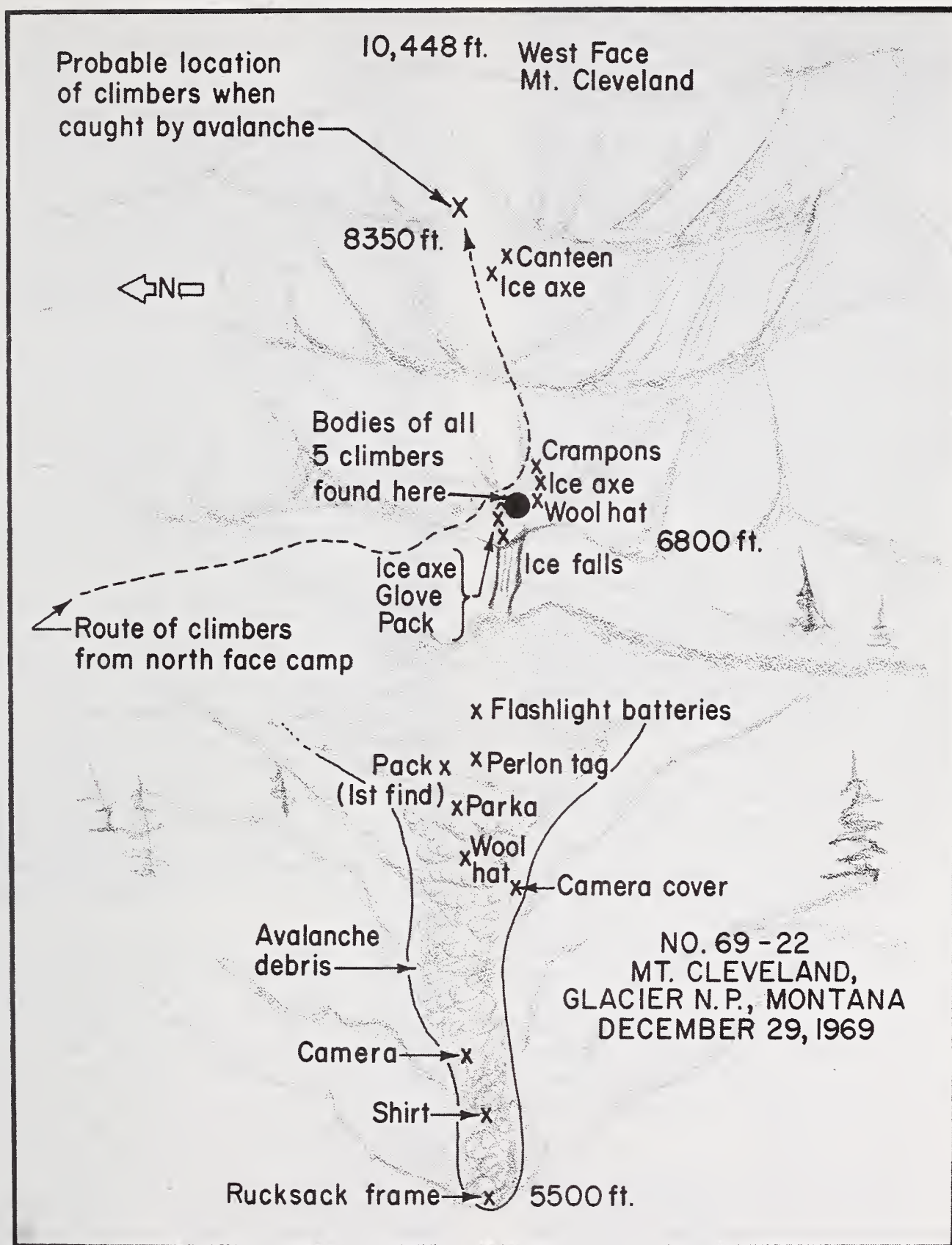
On January 2, Anderson and a Waterton National Park Warden went by boat to the

south end of Waterton Lake. No signs of the five climbers were found here. The two men returned to Waterton Townsite and contacted the Chief Park Warden's office. The Glacier National Park Superintendent was notified of the unfolding emergency situation, and an initial search and rescue operation was launched to locate the overdue climbers.

An air reconnaissance was begun early on the afternoon of the 2nd, and two men began hiking in following the climbers' tracks from the Waterton Ranger Station at the south end of Waterton Lake. The air search revealed no visible signs of the climbers, but the pilot did see the avalanche on the west face and reported either animal or human tracks leading into and out of it. The two ground searchers found a pair of skis and snowshoes belonging to the climbers about 1½ miles from the lake. The climbers' tracks were headed toward the north face of Mt. Cleveland. A ranger was sent to the Waterton Ranger Station to remain there in case the climbers should return during the night.

Early on January 3, two ground parties headed toward Mt. Cleveland. One party planned to search the northwest ridge route; the other would check beyond where the ski and snowshoes were found the previous day. About ½ mile above this latter point, the searchers found a camp with four backpacks, two tents, climbing gear, and a cache of food; this was about ¼ mile below the north face of Mt. Cleveland. Tracks were followed from this camp into the cirque below the north face where two snow caves were found. However, the caves had not been used as a bivouac site.

At this time it was evident that the five missing climbers had run into trouble; whether they were still alive was not known. Also, it was unknown whether they were on the north face or the west face of the mountain. Avalanches had been spotted on both the north and west faces. A full-scale rescue operation was launched on the 3rd with requests for technical climbers from Bozeman and Butte, Montana; from Grand Teton National Park; and from Jasper National Park in Canada.



The rescue climbers assembled on January 4 and began their search on the morning of the 5th. They organized into five groups assigned to cover the north face, the north-west ridge, the upper west face, the lower west face, and to man an observation post on Goat Haunt Mt., from which the north face of Mt. Cleveland could be observed.

Visibility had now improved and the air search, which had been hampered for the past 2 days was reinstated. A helicopter was used to make a close inspection of the north face; this revealed no trace of the five climbers.

The north-face searchers found no traces or signs of the missing climbers. However, the searchers on the northwest ridge found tracks leading up from the north side and then back down again. It was guessed that one or two of the missing climbers had used this ridge for a visual study of possible routes up the north face and then returned to the north side. The upper west-face group found no clues. Darkness caught them high on the face, and they were forced to bivouac there overnight. The lower west-face searchers also found nothing but they had been unable to work the avalanche debris because of the danger caused by climbers above them. The Goat Haunt observation group produced only negative results. All the other climbing parties, including the Goat Haunt observation personnel, were off the mountain by nightfall.

On January 6, probe lines were established across the north-face avalanche debris. At the same time, the support climbers who had bivouaced on the west face moved down to the debris area of the west-face avalanche. In early afternoon, this group found a pack belonging to the missing climbers; it was on the surface of the west-side avalanche and covered with a light skiff of snow. When this was reported, all but six men were immediately flown by helicopter from the north to the west side. Probing revealed a buried parka containing a camera and a can of film. The film was flown out and processed within hours but did not reveal any new clues.

On the 7th, although 80 percent of the west-side avalanche had been probed, and the same area covered with a magnetometer, no new clues were discovered. Most of the debris, however, was deeper than the 12-foot probe poles being used. The remaining area was probed on the 8th, again with negative results.

On January 9, a major storm struck the area, making further search efforts impossible. For several days the search team had

realized there was no hope of finding any of the five missing climbers alive. So when the storm struck, a press release was issued through park officials stating that the search was suspended for the winter. This decision was made after consultation with the parents and relatives of the missing climbers.

The following spring, when the snow began to melt, foot patrols were sent in every few days to search for new evidence. During this period, the west-face area of Mt. Cleveland was closed to public use. On May 23, a camera was found containing film that placed all five climbers on the west side. The next clue came on May 25 at the 8,300-foot level when an ice axe was found. During June, several additional pieces of climbing gear were found below the ice fall and at the toe of the avalanche. In late June, it was decided to make a summit climb to see if one or more of the bodies were hung up on the upper west face which had now melted free of snow.

On June 29, five men began the climb. Upon reaching the top of the ice fall, the men noticed a strong odor accompanying the melt water flowing from beneath the snow. A flashlight beam was aimed up the streambed beneath the snow; the first body was seen 30 feet upstream. The body was reached by digging down through 6 feet of snow; it was identified as Ray Martin. Tied to the body was a red perlon rope which extended uphill and disappeared beneath the snow. Trenching and probing revealed the second body, that of James Anderson, under 14 feet of snow. However, the body of Anderson was not tied to the red rope but rather to a gold one. From here, both the red and gold lines disappeared uphill into the snow.

The search was ended for the day with plans being made for the recovery of the other bodies. Film from Anderson's camera had been developed several days earlier. The last picture taken indicated that Jerry Kanzler should be at the other end of the red rope and that Mark Levitan would be in the middle and Clare Pogreba at the end of the gold line. All these expectations were later confirmed.

The final recovery effort began on July 1 and continued through the 3rd, three days of hard, unpleasant work. Probing, trenching, and eroding the snow with water using a nozzle, hose, and gravity-sock setup were all used to excavate the bodies from beneath more than 18 feet of snow and ice. Finally, on the afternoon of the 3rd, the bodies of the last three climbers—Kanzler, Levitan, and Pogreba—were removed and flown out by

helicopter. All rescue operations were concluded that evening: and the west face of Mt. Cleveland was again opened to the public.

Comments

Mountaineering is dangerous, particularly in winter; that is part of its appeal. Regardless of the expertise and the preparedness of its devotees, this sport will continue to claim its victims. However, undue risks can and should be avoided. The advice offered by rangers should always be heeded: they know their mountains well.

The Mt. Cleveland tragedy occurred in December 1969 but was not closed until July 1970. It marked the greatest number of deaths in the United States in a single avalanche since seven were killed at Twin Lakes, Colorado in 1962 (see *The Snowy Torrents* No. 62-3). The five young climbers—two on one rope, three on another—were high on the west face at about the 8,400-foot elevation when they

released an avalanche or were struck by one released above them. They were swept to the 6,800-foot elevation where they were hopelessly buried under tons of snow and ice. The avalanche occurred on either December 29 or 30, as best as can be determined.

The rescue was a major effort that was conducted as logically and smoothly as was possible under the circumstances. Search and rescue was conducted by United States and Canadian park personnel and involved support climbers from both the United States and Canada, and helicopter support from the United States Air Force and an independent flying service. Logistics was a major problem: men and equipment were transported to and from the mountain by boat on Waterton Lake until the lake froze; then by helicopter when weather permitted; and overland by ski-mobile. Total cost of the search and recovery exceeded \$19,000. Both the search and recovery efforts received national publicity, being covered extensively by radio, TV, and newspaper.

*1 caught and partly buried***Weather Conditions**

Precipitation had fallen at Alpentel every day from January 8 to 24. Daily snow amounts ranged from 1 to 14 inches, but water equivalents were high because some of the precipitation fell as a mixture of rain and snow. On the morning of the 23rd, 4 inches of heavy snow containing 1.24 inches of water was recorded. Eight additional inches had accumulated by the afternoon of January 24. Avalanche control on the 24th produced several medium-size avalanches.

Accident Summary

At about 1530 on the 24th, two young skiers, Diane Boender and Keri Coughlin, got off the upper chair and headed down International. At the bottom of this run the two girls decided to go through the trees to find untracked snow. They skied over to a run named Dom and started down. From somewhere above them, the snow broke loose and ran down the slope behind the two skiers. Boender was hit by the moving snow, but Coughlin escaped to the side.

Boender felt the snow pulling her down. She instinctively remembered that avalanche victims should try to swim with the slide. She thrashed her arms and this effort helped keep her head up. The avalanche carried her about 100 feet downhill before coming to a halt. She was buried chest deep in heavy snow. Her friend Coughlin, seeing she was apparently out of danger, skied down to summon help.

Rescue

Coughlin notified the lift attendant at the bottom of Chair 1, who in turn called the ski patrol at the top of the chair. Several volunteer patrolmen skied to the accident site to help the victim. Boender had a great amount of trouble digging herself out of the debris; the patrolmen then arrived and helped her out. All her equipment was intact, and she skied on down the mountain.

A short time later, the Alpentel pro patrol

learned of the accident and questioned the volunteer patrolmen to see if anyone else was involved in the accident. The volunteers had not questioned the two girls and had failed even to get their names. Assistant Snow Ranger Jack Gihlstrom was notified, and he in turn notified by radio Snow Ranger Ken White who was at a nearby ski area.

When White arrived at 1630, Gihlstrom and some of the pro patrol had already headed for the avalanche area with probes. They were proceeding on the possibility that other skiers could have been buried by the avalanche. Meanwhile, White stayed at the base area to try to find the girls who were involved in the accident. He finally found Boender who said she thought she and Coughlin were the only skiers near the Dom avalanche. To be absolutely certain there were no remaining victims, the searchers coarse-probed all the debris, which measured about 200 by 400 feet and was 4 feet deep. The results were negative, and the search-and-rescue efforts were concluded at 1735.

Avalanche Data

This avalanche was a point-release slide that started in a cliff area above the Dom ski run. This release point is above the normal control zone of this slide. It is unlikely that the two skiers triggered this avalanche; more likely, they were victims of a natural release in the cliff area. This avalanche most probably was a L-N-3. Starting in the cliff area, it ran some 500 feet down the slope, piling debris 4 feet deep.

Comments

The rescue work following this accident emphasizes an important point: *if there is any suspicion that there could be a buried victim, search the avalanche first and ask questions later.* This does not mean that a handy witness should be disregarded, for he may provide a life-saving clue. But time should not be wasted trying to track down unavailable witnesses.

It is important to remember that if skiers

are on the mountain, every sizable avalanche is a potential threat. If skiers were known to be in the area, it is mandatory that the avalanche area be searched (and probed, if warranted) for possible victims. There is always a chance that an unseen skier could have been buried. A tragic example of this is provided by No. 70-2.

In this accident, an initial mistake was made by the first rescuers when they failed to question or hold the witnesses and failed to initiate a hasty search of the avalanche area. The pro patrol and assistant snow ranger acted correctly by initiating a coarse probe of the debris before trying to locate the witnesses.

4 caught; 2 partly buried and 1 buried; 1 killed

Weather Conditions

A large storm moved into the Wasatch Range in Utah on the afternoon of January 27. By the morning of the 29th, 37 inches of snow had fallen, increasing the snow depth on the ground from 74 to 101 inches. The snow had a water equivalent of 2.87 inches. The temperature was in the middle twenties when the storm began but had dropped to 2°F on the 29th. Winds averaged 25 m.p.h. from the west and west-northwest with gusts to 45 m.p.h.

Avalanche control was carried out early on the 29th with several small and medium avalanches being reported, enough to raise suspicion especially with 3 feet of new snow. The Lower Peruvian Ridge route was run by two patrolmen. They threw three hand charges (one of which was a dud) and ski checked the ridge area, releasing a few minor sluffs. The chute in which the accident later occurred was not controlled with explosives but received two ski cuts. No signs of significant instability were seen in this area; therefore, at about 1030 the Peruvian Ridge area was opened to the public.

Accident Summary

At 1145 a group of skiers unloaded from the Wildcat lift and headed for the Lower Peruvian Ridge area for the purpose of filming a promotional movie of skiing at Alta. The party consisted of four Alta ski instructors, including Max Lundberg and Alf Engen, and two cameramen. As they left the lift, some of the group spoke to Ted Manusama, a local skier and employee of the Alta Lodge. Manusama was interested in the movie project and followed behind the party as they traversed towards Lower Peruvian Ridge.

They arrived at the slope where the movies were to be taken and began setting up. Lundberg and Engen were to ski down toward the two cameramen who had spaced themselves lower on the slope. The other two men were to observe from above and ski down later. The four ski instructors began a short hike to reach the top of the ridge and, preoc-

cupied with their project, lost track of Manusama. The last time any of the skiers or cameramen noticed him, he was to the side of the slope that was to be skied.

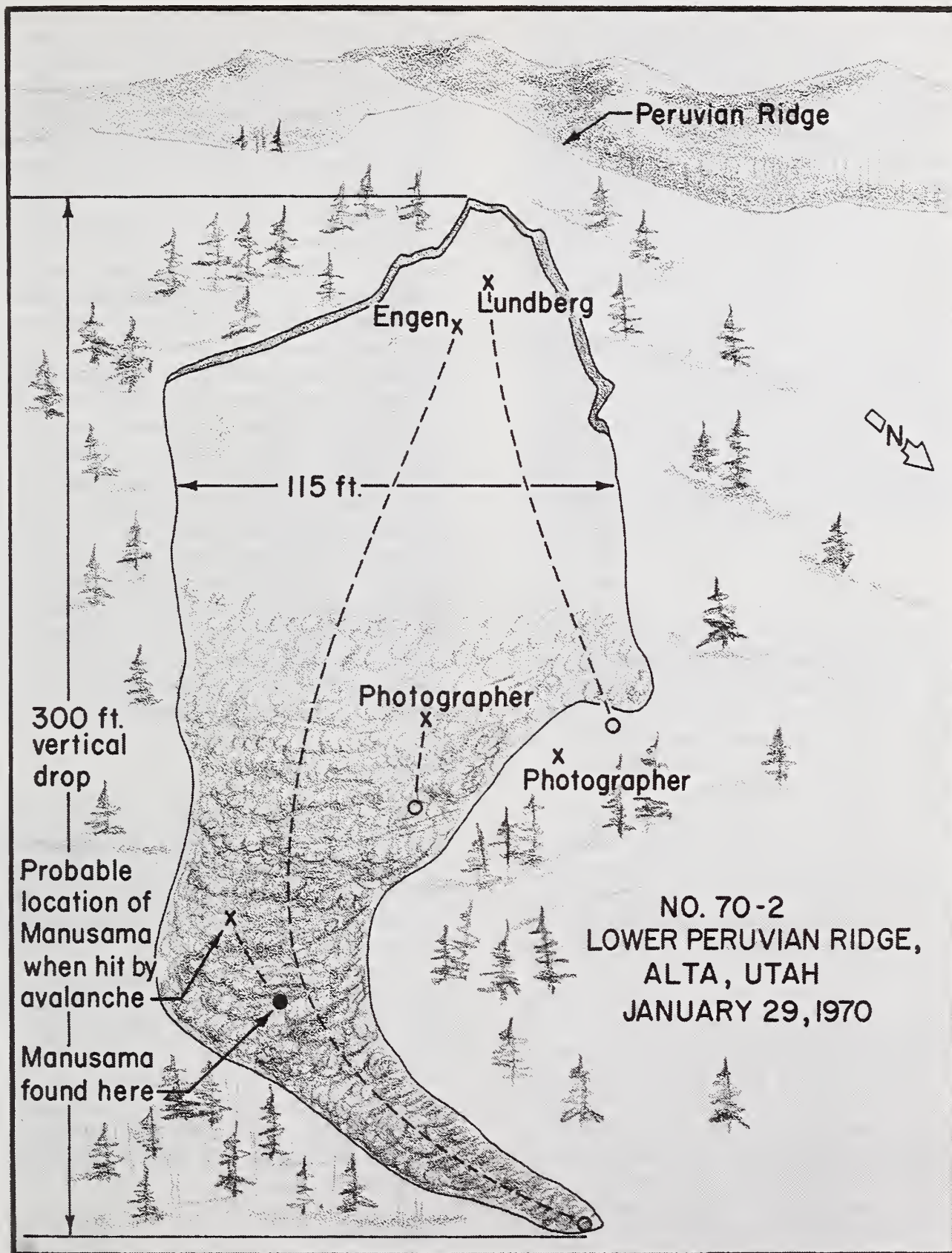
Lundberg and Engen began their descent, and the cameras began rolling. Both skiers had made two turns, Engen farther downhill than Lundberg, when the snow fractured above and around them. Lundberg didn't see the snow fracture but knew for some reason he was having trouble keeping his balance. He then realized he had been caught in an avalanche and struggled to keep his feet. He maintained his balance, skied with the slide, and came to a stop at the edge of the moving snow.

Engen saw the snow fracture out of the corner of his eye. A powerful skier, he pointed his skis straight downhill trying to ride the slide out. With a lot of snow above him and overtaking him, he had trouble standing up in the churning mass. He gained speed quickly and zoomed downhill and out of sight as the avalanche turned a corner below a small knoll.

One of the cameramen was directly in the path of the avalanche. Engen almost hit the man as he shot past, but there was no way for the cameraman to avoid being hit by the avalanche. The avalanche struck with force, scattering his equipment and sending him somersaulting downhill. He was buried to the neck when the slide came to a stop. The other cameraman was to the side of the avalanche and was not caught.

Rescue

After the slide had stopped, those who were not caught began counting heads. Lundberg was all right on the edge of the slope. The buried photographer was spied, his head sticking above the debris. That left only Engen who was nowhere to be seen. They assumed he had been buried in the slide and began probing with ski poles. One of the members left the group to ski to the bottom for help. Following the slide path down, he turned the corner around the knoll and saw Engen climbing back up the debris. He had ridden the slide to the



very toe, unobserved by his companions. * After Engen had been found and the photographer dug out, it was mutually agreed that everyone was safe and no other person had been involved.

Two skiers riding the Wildcat lift had witnessed the avalanche. They had been watching the filming party and, moments before the avalanche occurred, had noticed a skier in an orange parka. Although this skier was in the same general area as the filming group, he was obviously not involved in the movie taking. The two witnesses paid no more attention to the skier in the orange parka, especially once the avalanche released and they became engrossed in watching the slide.

Finally the two witnesses unloaded from the chair, skied to the accident site, and asked if they could help. It was just then that Engen was located, so the two witnesses were told everyone had been accounted for. The two witnesses then skied off.

Meanwhile, one of the filming crew had skied to the bottom and reported the accident to the pro patrolman on duty. The patrolman was told that apparently everyone had been accounted for but that possibly Ted Manusama had been caught since he was in the Peruvian Ridge area. The patrolman began organizing a rescue and contacted Snow Rangers Bengt Sandahl and Will Bassett by radio. Sandahl was on the mountain and skied to the accident site; Bassett went to the bottom and helped organize a rescue team.

Sandahl arrived at the accident site and questioned those involved whether anyone else had been buried. He was told that Manusama had been with the party earlier but had skied off. A set of ski tracks beyond the avalanche area were identified to Sandahl as probably belonging to Manusama. At this time, the two skiers who had witnessed the slide from the chair once more skied up to the site. They told Sandahl they had seen a skier in an orange parka nearby but thought he could not have been anywhere near the avalanche. Sandahl was then told by the movie makers that Manusama was wearing an orange parka. To finalize the consensus that Manusama couldn't have been buried, the two skiers who had started the slide, Lundberg and Engen,

said pretty definitely that they were the only skiers caught by the avalanche.

Sandahl then skied down to where Bassett and the ski patrol were leaving for the rescue. Some rescuers had already started up. The snow rangers and patrol weighed all the eyewitness reports of the six skiers in the movie party and the two skiers on the chairlift. The consensus was that Manusama had skied out of the area before the avalanche began and could not be buried. The rescue was, therefore, called off, and the rescuers who had started up were called back.

At 1700, after the lifts had closed, the Alta Lodge was checked; Manusama had not yet reported for work. Ski patrol leader Jim Head had just returned from sweep when the Alta Lodge called. Head immediately told all patrolmen to get their skis on, and the rescue was set in motion. The first probe line consisting of about 14 probes was set up at about 1800. At 1830 the body of Ted Manusama was found, clad in an orange parka. He was located under 3 feet of snow, head downhill and no indication of an ice mask around the face. All his ski equipment was intact, indicating he had been carried only a short distance by the avalanche.

Although oxygen was administered immediately, Manusama showed no signs of revival. He was pronounced dead from asphyxiation at Cottonwood Hospital in Salt Lake City.

Avalanche Data

This avalanche was a SS-AS-3. It was 115 feet wide in the starting zone and fell 300 feet vertically. The fracture line was 3 feet deep, failing on a very steep slope of 47°. This particular slope along Lower Peruvian Ridge has a northeast exposure.

The toll for this avalanche was four caught, two buried, and one killed. The two skiers who triggered the slide survived; the victim, unseen by the others, was low on the slope and was buried deeply by the large amount of snow descending from above. As in so many other avalanche accidents, this points out that the persons lowest in the track are in the greatest danger.

Comments

The lesson to be learned from this accident is very simple, very blunt. It is this: *the safety of skiers is not best served by inaction after an avalanche accident.* The possibility exists that, for any avalanche large enough to bury a person in any ski area, an unseen skier

* In a skiing career of 40 years, this was Engen's third escape from a major avalanche. In all cases, he kept his skis on and skied out of the slide.

could have been buried. This is a principle that cannot be compromised. Accordingly, avalanche rescue policy at all ski areas should be rigid on this one point: every avalanche suspected, however slightly, of burying a skier must be probed without exception. Alta now adheres strictly to this policy.

The decisions of rescuers must not be based solely on the reports of witnesses but must include all possibilities. Admittedly the eyewitness reports following this accident were mostly unanimous and convincing that Manusama could not have been buried. Nevertheless, he was known to have been in the area at the time of the avalanche, and his presence following the accident was unaccounted for. Thus, strict policy should have been followed and a rescue initiated. The hard fact remains that the victim would have been found within 90 minutes instead of 6 hours. Would this have saved his life? This question cannot be answered, but no buried victim should ever be denied this chance.

Finally, this accident starkly points out the danger of skiing alone. Manusama was skiing alone and therefore was not actually missed until later in the day. A skiing companion would have sounded an immediate alarm, giving Manusama an excellent chance of survival.



No. 70-2. Lower Peruvian Ridge, Alta, Utah. This photograph showing the fracture line in Lower Peruvian Ridge was taken the day after the accident. The figure at the bottom is standing at the spot where the victim was found.

3 caught; 1 partly buried, and 1 buried

Weather Conditions

On February 15, a storm moved across northern Idaho bringing heavy snows to the higher elevations. By the morning of the 16th, 18 inches of damp, heavy, new snow had fallen at Schweitzer Basin Ski Area and increased the total snow depth to almost 90 inches. The storm was still in progress on the morning of the 16th with the temperature holding at 31°F.

Accident Summary

Before the lifts were open to the public on the morning of the 16th, two ski patrolmen, John Pucci and Phil Owens, and a ski instructor, Glenn Phillips rode up Chair 1 to test ski a slope near the chair called the Face. Pucci and Owens worked the south side of the Face with no results. Phillips worked down the north side and released several small sluffs. He then traversed across the center of the slope and ended up on the south side, about 50 feet below the two patrolmen. He came to a stop with a hard jump turn; immediately the entire south side of the Face fractured and was set in motion. The fracture line broke 90 feet upslope of Phillips and 40 feet above Pucci and Owens. All three men were caught by the slide.

Owens was nearest the edge; he was carried 150 yards downslope and came to rest on top of the snow. Pucci was carried 175 yards and was buried to the waist. Phillips was hit by the main part of the avalanche; he rode on top for the first 20 yards but then was pulled under. He was carried a full 250 yards to the toe of the debris. In his own words, Phillips describes his experiences:

"I skied to a stop about 50 feet below Pucci and Owens and then everything started moving. I remember calling out as I looked up the hill and saw them floundering, so I knew it had fractured above them. After I went under the snow the problem was to try and keep the snow out of my mouth. I can remember coughing violently and trying to keep my hands over my mouth which was nearly impossible. Somewhere along the line, my ski cap was pulled

down over my nose and mouth. This made breathing less difficult. The wet snow tossed and turned me quite violently during the ride down. I remember two very solid jolts, as if I had been slammed against the ground. I had removed my wrist straps and lost my poles immediately, but my skis did not come off and it seemed as if they were pulling me under as I slid. When the slide stopped I was face up, two feet under the snow, with my feet downhill. My left hand was near my mouth and I managed to punch a small hole for breathing and also to push up my hat which had slid down over my face. As I did this, I noticed that it seemed lighter above me. I punched violently upward with my left hand and my fingers broke through the snow. I kept trying to enlarge the hole, but in the process knocked loose snow into my mouth, making breathing difficult. It was this hand movement which was seen from the chairlift and led to my being quickly dug out by the rescue crew."

Rescue

Two other ski patrolmen had also ridden up the chair. They remained at the top terminal and were provided with a ringside seat to the whole avalanche. When the snow came to a halt, they could see only Owens and Pucci on top of the snow. They phoned to the bottom for rescue assistance and then skied over to Owens. He was unharmed and on top of the snow; all three then proceeded to Pucci and dug him out.

No signs of Phillips were yet seen. All four men began working their way down the slope searching for clues. At this time, the first member of the rescue party was on the chairlift and spied a gloved hand sticking above the snow near the toe of the avalanche. He shouted to the four men on the snow and directed them to the spot.

Phillips was found with his head 2 feet beneath the snow; one arm was jutting upward and his hand was on the surface. Gasping for air, he was immediately uncovered and helped from the snow after being buried only a few minutes. All three men who were caught suf-

ferred slight injuries but gained valuable experience from their ordeal.

Avalanche Data

This slide was a SS-AS-3 which resulted from shallow instability in the new snow layer. The Face is a fairly steep east-facing slope (34° near the top) that is skied regularly. The few trees scattered on the slope were not numerous enough to anchor the snow cover. The avalanche was some 75 yards in width and 300 yards in length.

Comments

Test skiing should be programed only on

small slopes. This slope—the Face—is much too large for test skiing and should have been controlled with explosives before being skied. In addition, this group's test-skiing technique leaves much to be desired: it exposed all three members of the team to danger. Only one skier at a time should have been exposed while the other two stood at points of safety.

A number of avalanche victims have been quickly rescued alive because they had thrust a hand upward, reaching the surface (see No. 67-9 for example) just as the avalanche was coming to a stop. This is certainly one way that avalanche victims can help themselves and should be considered as important as forming an air pocket.

1 caught, buried, and killed; 1 vehicle damaged

Weather Conditions

Snow began falling over the San Juan Mountains of southwestern Colorado on February 28 as another winter storm advanced into the area. Eight inches of new snow had accumulated by March 1 at the Idarado Mine which is located along U.S. Highway 550 just north of the summit of Red Mountain Pass. Twelve more inches had fallen by the morning of the 2nd and increased the total depth of snow from 49 to 69 inches.

Accident Summary

Colorado's "Million Dollar Highway" is that stretch of U.S. 550 running from Silverton to Ouray and snaking up to the summit of 11,075-foot Red Mountain Pass. It is perhaps the most scenic and also the most treacherous major roadway in the state. Nearly 60 avalanche paths threaten this 23-mile stretch of highway in winter. Some of these avalanche paths are among the largest in the state and pose an ever-present threat to motorists and workmen clearing the road below.

The first sign of danger from this February 28 storm occurred at 1000 on March 1 when the Blue Point avalanche ran across the highway to a depth of 8 feet. This small avalanche path is located just north of the pass summit and runs with every sizable storm. At 2230 on March 1, two more avalanches ran across the road: Slippery Jim covered the road 10 feet deep; East Riverside, 15 feet deep. The road was now impassable and more unstable snow was hanging above; the highway gates were closed and locked on each side of the pass until the road could be cleared and avalanches controlled with artillery the next morning.

On the morning of March 2, a group of Colorado Highway Department employees began the slow work of clearing the avalanche debris from the highway. The crew was working the East Riverside debris around noon when all but one man left for Ouray to pick up some additional equipment. Robert Miller, age 36 and a father of seven, was left alone working with a D-7 cat under the East River-

side avalanche.

Just a few minutes before noon, the East Riverside avalanche struck again! A large slab of snow broke loose from the starting zone and rumbled down the track. Miller had no chance to escape as the wall of snow hurled him and his machine into the canyon below and buried both under tons of snow.

Rescue

The rest of the work crew was returning from Ouray when they sighted an avalanche dust cloud filling the canyon a few miles ahead. "Oh, God! He's gone," gasped one of the men, realizing that this was the East Riverside avalanche and that Miller was working beneath it. They radioed for help and hurried to the scene; within a short time about 50 men began probing the area. At 1330, the D-7 cat was found under 7 feet of snow. The massive machine had been carried 300 feet across the canyon by the avalanche!

The search for Miller continued without success. At 1530, the probe line was halted by the sheriff because of deteriorating weather and the threat of yet another avalanche. This threat came from both East Riverside and from West Riverside, which lay on the opposite side of the canyon and had not yet run.

The following morning the 75-mm pack howitzer was brought out to fire on the avalanche paths. Both the East and West Riverside slide paths were shot with several rounds without releasing any snow. However, three other slides along the highway were brought down by artillery fire. Because rescue operations were still considered hazardous, no probing of the avalanche area was carried out that day.

On the morning of the 4th, the rescue began again with probe lines and bulldozers to move out some of the deeper snow. Finally at 1630, the body of Robert Miller was found under 4 feet of snow and 120 feet from where his damaged cat lay. His watch had stopped at 1156, the moment of impact of the clubbing avalanche. The body was removed and the rescue was concluded by 1800.

Avalanche Data

The East Riverside avalanche is a particularly dangerous path that produces large slides and runs frequently. Almost 7 years earlier to the day it claimed three other victims (see *The Snowy Torrents* No. 63-2). The slide falls some 3,200 feet vertically down the northwest flank of Abrams Mt., and hits the highway directly. As it crosses the road, the avalanching snow then falls into the gorge below. The avalanche hits the highway six times in a normal winter.

Another factor making East Riverside so dangerous is its habit of running more than once over a short time span. Because of the huge 75-acre catchment basin, even if only a third of the basin avalanches, the road can be hit by a large volume of snow. This still leaves a larger volume hanging above the road—ready to slide at a later time! To further compound this problem, no part of the starting zone is visible from the road below: motorists and highway crews have no visual warning before the snow sweeps across the road.

Both East Riverside avalanches in this report were classified as SS-N-3; the first released from the top left of the catchment basin and the second from the top center. A total of 19 avalanches resulting from this storm were

observed along the Million Dollar Highway, but the East Riverside dominated the action as usual.

Comments

Considering the potential severity of the avalanche problem, it is surprising that there have been so few avalanche accidents along Red Mountain Pass. The highway department's policy of closing the highway under extreme conditions is of primary importance here. The policy is made workable by the relatively low volume of traffic along the highway. The artillery control program is also vitally important but still is limited by no provision for blind firing during periods of poor visibility. Optimum use of artillery demands that blind firing be incorporated into the control program.

Even the best control policies, however, cannot completely protect the men who must clear snow from the road. When clearing out avalanche debris they are particularly vulnerable, with no place to go should an avalanche release above them. Even the enclosed cab such as that occupied by Miller is of no help when struck by a large avalanche. A long, heavy avalanche shed is the only sure protection from the East and West Riversides.

1 caught, partly buried, and injured

Weather Conditions

Overnight, March 27 to 28, 13 inches of snow fell at Jackson Hole Ski Area. This snow fell on a sun crust that had formed during a period of warm sunny weather earlier in the month. On March 30, the weather was

clear and cold with northeast winds that averaged up to 31 m.p.h.

Accident Summary

Late on the morning of March 30, a party of five skiers left the patrolled and controlled



No. 70-5. Jackson Hole, Wyoming. The Four Pines touring area. The arrow marks the victim's ski tracks leading into the fracture line.

boundary of the ski area for a ski tour in the Four Pines area. With the group was a Jackson Hole ski patrolman who acted as a guide for the party. The skiers approached Four Pines via the ridge between the Green River and Pinedale bowls. Four of the skiers, including the guide skied into the powder on a timbered north-facing slope. Rich Ream, 52, skied off by himself, however, onto a mostly open, east-facing slope on which a hard wind slab had formed from the strong northeast winds.

At about 1215, Ream skied across the top of Four Pines, did a kick turn, made about five turns down the fall line, then fell. He got up and had made about five more turns when the entire hill fractured 200 feet upslope from him. He was engulfed by the avalanche and carried helplessly on a fast ride through some trees.

The rest of the party did not know the avalanche had run until they saw the debris. They located Ream at about 1230 well down the slide path but on top of the snow. He had been carried down approximately 700 feet vertically and had sustained severe injuries during the ride. A request for a rescue party was quickly sent to the ski area.

Rescue

A hasty rescue party left Rendezvous Peak at 1240 equipped with emergency first aid equipment. This party was followed shortly by a second party of four patrolmen carrying a toboggan. Ream's injuries were severe—facial cuts and broken bones in both arms and both legs. He was taken back to the ski area in the toboggan and then transferred to the hospital in Jackson.

Avalanche Data

This avalanche was a HS-AS-3 that consisted of an unstable new snow layer sliding on a hard snow crust. Although triggered by a single skier, the slab fractured along a broad front and fell 1000 feet in elevation. The Four Pines area is lightly to moderately timbered and is an east- to northeast-facing slope.

Comments

Although ski touring was open at Jackson Hole, it was restricted to groups with guides only. This touring party did have a guide. However, the victim got into trouble when he departed from the group to ski the open slope on which a dangerous wind slab had formed.

*3 caught***Weather Conditions**

Total snowfall had been normal in the Wasatch for the winter of 1969-1970. April snowfall, however, had been considerably above average assuring a lingering, deep snowpack at high elevations as spring stretched toward summer. Exceptionally warm weather made the weekend of May 16 and 17 excellent for hiking in the mountains. Both days saw the temperature reaching into the upper seventies even at higher elevations. A warm, dry wind blew in from the west across the Great Salt Lake.

Accident Summary

On Sunday, May 17, four young people were picnicking up Big Cottonwood Canyon east of Salt Lake City. They had picked a spot along a stream near the Storm Mt. Picnic Ground and near the mouth of Stairs Gulch.

Around 1500, the four picnickers watched as three hikers walked by and headed toward Stairs Gulch. A short time later the four young people were amazed to see the stream in front of them suddenly stop flowing, quickly being reduced to a mere trickle. Curious, they walked around a huge boulder upstream from their picnic site and saw that an enormous wet-snow avalanche had slid down Stairs Gulch and dammed up the stream. The avalanche had missed the picnickers by little more than 100 feet, piling debris 50 feet deep across the streambed. They quickly remembered the three hikers that had gone into this area only a short time earlier. No sign of the hikers could now be seen anywhere up the canyon. One of the picnickers then hurried to the nearest telephone to alert the Sheriff's office.

Rescue

The Sheriff's Search and Rescue group responded by rounding up a crew of men and sending them to the avalanche area. Probe poles were sent down from Brighton Ski Area, and a total of 17 men began probing the

debris. At the same time a check of vehicles at the picnic ground parking lot was established to check for any missing persons in the canyon.

As the probing continued, U.S. Forest Service District Ranger Ames Harrison climbed to the top of Stairs Gulch seeking the missing hikers. At about 1830 while at a safe vantage point at the top of the gulch, Harrison saw the remaining snow in the catchment basin suddenly break loose! He instantly radioed to the rescuers at the bottom that another avalanche was on its way.

The rescuers scattered, some fleeing across the stream and others clawing up the rock sides of the gulch. The wet snow avalanche was not fast moving, and all men made it to safety; three men, however, were caught but not buried by the moving snow.

After this narrow escape, the rescuers regrouped to determine whether anyone was missing. It was ascertained that all the men were accounted for. Meanwhile, the car check had revealed neither unattended cars nor any reports of missing persons in the canyon. In view of the unsafe working conditions, it was decided to suspend the rescue operation unless some evidence turned up indicating that someone might be buried in the avalanche.

No missing persons report was ever filed, and finally when the snow melted out weeks later, no victims were found. Although no one had been buried in the first avalanche, the rescuers did not know this and were forced to search for possible victims. The rescue effort narrowly averted a disaster of its own.

Avalanche Data

Both avalanches running out of Stairs Gulch were classified as WS-N-4. Warm air temperatures and strong solar radiation had greatly weakened the deep snowpack in the starting zone, bringing it to an isothermal state. This finally resulted in failure. The slides were wet, heavy, and slow moving. Both ran about 1½ miles in length, dropped approximately 3,500 feet vertically, were 150 feet in width, and deposited snow about 50 feet in

depth in the runout area.

Stairs Gulch is a huge northwest-facing gully that has run even larger in the past. On several occasions it has reached the highway in the bottom of the canyon, a vertical drop of some 4,500 feet. The steepness of the starting zone varies from 35° to 45°, and its bowl-shaped catchment area allows snow to be trapped from all wind directions. All these factors taken together make this a highly erratic and dangerous avalanche path.

Comments

Deep, isothermal snowpacks in late

spring are ripe for deep-instability avalanches. It is common for these to run in a piecemeal fashion, increasing the possibility of several avalanches down the same track over a short time interval. Rescuers should be aware of this capricious quirk of avalanches and should always be prepared to make a hasty escape. A timely warning prevented this rescue effort from becoming a tragedy within itself.

This incident vividly emphasizes the importance of a "lookout" for avalanche rescues. Rescues conducted without a specifically posted guard are risky at best.

*1 caught, buried, and killed***Weather Conditions**

A storm moved in from the Pacific on Saturday, December 26, bringing more snow to the North Cascades. By Sunday morning, 4 inches of snow had fallen at the Mt. Baker Ski Area. The storm continued and dropped 19 additional inches of snow by the afternoon of Monday, December 28. The depth of snow on the ground was approximately 125 inches. Temperature during this period ranged from 20° to 28°F; winds were mostly from the south and averaged up to 17 m.p.h.

Avalanche control was carried out routinely on Sunday the 27th, and eight small soft slabs were released. On Monday morning, 12 small avalanches were released and the ski area was opened by 1030.

Accident Summary

Snow continued to fall and the wind blew throughout the day. At 1515 on the 28th, Rolf Mueller and Klaus Kerstan unloaded from Chair No. 4 and skied for a distance of about 350 feet toward the White Salmon run to the east of the chair; here the two men stopped on a cat track near a tree. Mueller then skied on alone for about another 200 feet before stopping and looking back for Kerstan. Visibility was very bad because of the continuing storm, and the two skiers did not want to get separated.

Mueller saw Kerstan ski away from the tree, but failed to locate him when he looked back a few seconds later. At this time a small avalanche ran over the back of Mueller's skis. However, this appeared to be just a small sluff and he paid it little attention.

He waited a few more minutes and then skied slowly down White Salmon, expecting Kerstan to catch up. Mueller then waited at the bottom of the chair and eventually skied two more runs looking for his friend. When the lift closed, he went to the base area and checked Kerstan's car, the shops, and the bar. Mueller decided that Kerstan was missing, and at 1610 he notified the ski patrol.

Rescue

The patrol questioned Mueller to learn where Kerstan was last seen and on what part of the mountain he could be lost. Mueller said they had been on Shuksan Arm skiing the White Salmon run. It was only after a few minutes of questioning that Mueller mentioned the small avalanche. At this time another patrolman came in from sweep and confirmed that a small slide had run over the cat track on White Salmon. Snow Ranger Mike Dolfay was notified and a hasty search was organized.

At 1740 the first search party of eight men arrived at the slide area equipped with probes, shovels, and flashlights. The continuing snowfall and wind had obscured the surface of the slide making the boundaries and extent of the debris indefinite. The rescuers systematically probed the debris covering the cat track and finished at 2045 with negative results.

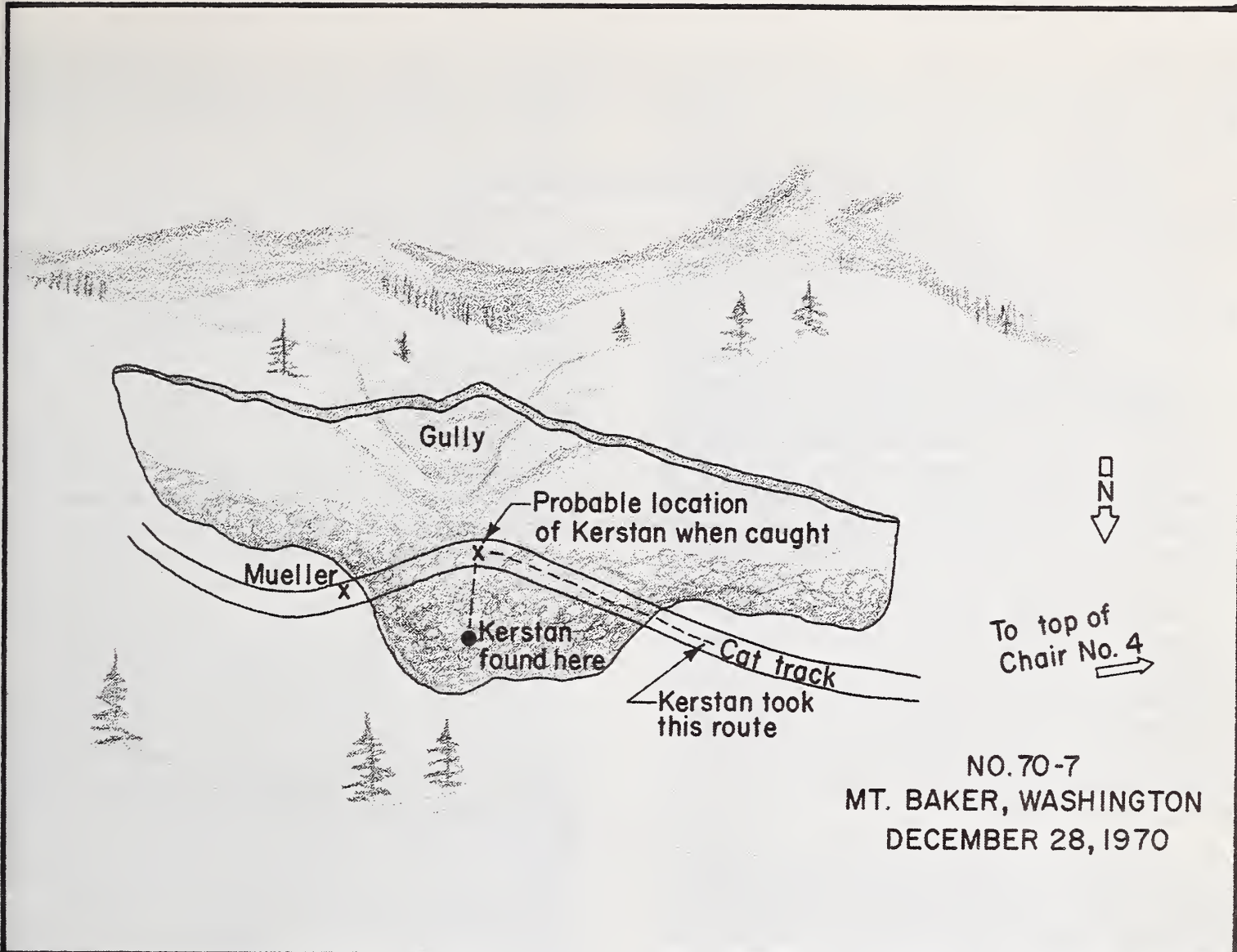
The rescue party returned to the base area and made preparations for another search effort that included a snow cat equipped with a front-end blade to remove some debris for easier probing. This party reached the slide area and began work at 2340. At midnight the body of Kerstan was struck with a probe pole about 30 feet below the road and under 6 feet of snow.

It took some time to shovel down through the hard snow, but after 10 minutes of hard work the body was uncovered. Kerstan was found face down in a prone position without any signs of life. He was taken to the base area in a toboggan where a doctor pronounced him dead. It was felt he had died very quickly of suffocation, probably within 5 or 10 minutes after being buried.

Avalanche Data

This small avalanche was classified as a HS-N-1 running about 140 feet slope distance and 50 feet vertically. The fracture line was 2½ to 3 feet deep and extended a length of 200 feet. The slide occurred on the north side of Shuksan Arm at an elevation of 4,800 feet.

The terrain in this part of Shuksan Arm is



NO. 70-7
 MT. BAKER, WASHINGTON
 DECEMBER 28, 1970

typically benchy with numerous rolls and gullies. The avalanche was centered in a small gully that did not have a past history of sliding. The steepness of the starting zone varied greatly—35° to 24°—because of the rolling terrain. However, the slope was undercut by the cat track which removed support from below. The unstable slab fractured under the added stress of the new snow accumulation during the previous 36 hours. Wind had increased new snow deposition to about 36 inches in the small gully.

Comments

Normally an avalanche of this size would fall in the category of a harmless bank sluff. But fate intervened in this case and placed the victim, who was traversing the cat track, di-

rectly under the slab at the moment of release. He was carried into the shallow gully, and the volume of snow was sufficient to bury him deep enough to snuff out his chance of survival. This accident is another example of a small avalanche becoming a killer (see also *The Snowy Torrents* Nos. 62-7 and 64-11).

This type of benchy terrain makes effective avalanche control difficult. There are innumerable small pockets to trap blowing snow. During storm periods, hazard can build up quickly after avalanche control has been completed in the morning. This is the kind of situation that requires continuous checking during the day to prevent serious slab conditions from forming. When such conditions are suspected, there should be no hesitancy to close the area to skiing until control measures minimize the hazard.

*1 caught, buried, and killed***Weather Conditions**

A major snowstorm moved into the Sierras on December 16 dumping up to 60 inches on the ski slopes around Lake Tahoe by the 22nd. The snowpack had reached a depth of about 60 inches in the Alum Creek area. This region lies at the 7,600-foot elevation on the eastern flank of the Sierras and is about 4 miles southwest of the suburbs of Reno.

Another storm began on December 26 bringing snow and strong southwest winds of 30 to 45 m.p.h. The Reno airport was temporarily closed by this storm on the 27th. This storm continued on the 28th with snow, strong wind, and a temperature of 20°F.

Accident Summary

At 2100 on December 28, a party of four men on four snowmobiles left Skyline Blvd. in southwest Reno for an evening of snowmobiling. In spite of the near-blizzard weather conditions, the group headed for steeper terrain, up the Hunter Lake jeep road. They followed the road for about 5½ miles until coming to a steep slope above Alum Creek where the road begins to switchback. The men abandoned the road at this point and attempted to climb directly up the slope, but it proved to be too steep. They then began a traverse across the slope in an attempt to gain altitude.

Each machine cut a separate path across the slope with David Woodward lowest of the four. While midway onto the slope one of the drivers glimpsed a running avalanche illuminated by the headlight of his machine. He could also see Woodward's headlight lower on the hillside directly below the avalanche. This headlight was visible for a short time, and then it went out! The time was 2245.

The three other drivers had not been involved in the avalanche and immediately went downhill to check on Woodward. His track was plainly visible leading into the slide, but there was no track leading out. The men scuffed the surface of the debris but could find no sign of Woodward or his machine. While two men stayed to search, the third, Marvin McKinney,

headed back down the Hunter Lake road to summon help.

Rescue

McKinney arrived at the fire station on Skyline Blvd. at 2347 and reported the accident to the Washoe County Sheriff's Department. The Washoe County Jeep Squadron was alerted and, in turn, the Reno Sno-Drifters Rescue Group was notified. The Sno-Drifters were a section of a local snowmobile club who had received first aid and rescue training.

At 0022 on the morning of December 29, Sgt. Glen Vogler of the Sheriff's Department arrived at the fire station and assumed leadership of the rescue group. He had participated in numerous other search missions, but this was his first avalanche rescue mission, and he had received no training in avalanche hazard or search techniques.

At 0115, McKinney led men with snowmobiles toward the accident site. A second party of eight more rescuers left the fire station 10 minutes later. By 0230 there were 23 men at the accident scene to help the two men who had been searching in vain for their lost companion. Almost 4 hours had passed since Woodward had been buried, giving him little chance of survival. Tom Newton, the head of the Reno Sno-Drifters, assumed leadership of the rescue at this time.

The rescuers were working under hazardous conditions. Strong winds were producing near-blizzard conditions, and a considerable amount of snow was still hanging on the slope above. In addition, the men were very poorly equipped for an avalanche rescue; they had only two probe poles among them. Nonetheless, an organized search was initiated near the toe of the slide and proceeded across the slope toward the victim's entry track. Progress was very slow because of the lack of probes. After a few minutes, Newton decided to abandon this procedure for a more random but more rapid search. The debris had set up such that walking on the snow was easy but probing into it was very difficult, especially without standard avalanche probes.

At 0258 a runner of the buried snowmobile was struck under 6 inches of snow near a stand of aspen trees. Frantic digging uncovered the machine upside down. Woodard was uncovered beneath and to the side of the machine under 4 feet of snow. His foot was pinned between the snowmobile and a tree; there were signs that he had struggled to get free. Although body warmth was still present, there were no other indications of life. Artificial resuscitation and external heart massage produced no response from the victim.

A snow cat had been brought to the accident scene and was used to carry the victim back to the Skyline Blvd. fire station. A doctor pronounced him dead at 0554. All rescuers and equipment left the accident site a short time later, concluding the rescue operation.

Avalanche Data

This was a medium-size hard-slab avalanche triggered by a snowmobile traversing the slope. All or any one of the four machines crossing the slope on different tracks may have triggered the slide. The slab broke beneath a small cornice at the top of the slope. The slide was about 250 feet in both width and length; it dropped some 120 feet vertically.

This north-facing slope is very steep—about 45°—near the top where the avalanche released and flattens to 25° to 30° farther downhill. The top of the slope lies at an elevation of 7,600 feet with a cornice forming at the ridge and the steep lee slope providing an excellent catchment zone. The strong southwest winds swept across the flatter windward slope and redeposited the snow on the steep north slope. The resulting hard-slab avalanche left table-size blocks of snow at the foot of the slope.

Comments

This accident marks the second avalanche fatality to a snowmobiler; the first is

documented in No. 68-7. (A third fatality occurred in January 1971. See No. 71-7) The thought of avalanche apparently had not entered the minds of these four snowmobilers. The sum of their errors led to tragedy.

First, the men exercised poor judgment in touring in steep terrain during a raging snowstorm. Going at night compounded this error. The combination of heavy snowfall and forceful winds had created very high avalanche hazard. Storm periods are the most dangerous while touring in avalanche terrain: more than 80 percent of all avalanches fall during or immediately after storms.

Second, they crossed the slope in an unsafe manner. The group should have crossed one at a time following the same track rather than all crossing at once and each taking a separate path.

Third, the men were unprepared in the event of emergency; they had no rescue equipment of their own. On any back-country tour, it must be realized that the survival of a buried avalanche victim rests solely with his companions. Additional help is too far away to allow a live rescue. In this case, collapsible probe poles and a shovel or two may have resulted in a saved life.

Finally, this accident points out the need of avalanche training for snowmobile touring groups and for anyone who might be involved in an avalanche rescue. Knowing the danger signs would have kept this group at home, knowing the safe traveling procedure would have minimized the chance of triggering the avalanche, and having emergency rescue equipment would have given the buried victim a much better chance. The rescuers, too, were inadequately prepared for their mission. They had neither adequate rescue equipment nor adequate training. To remedy these deficiencies, club leaders should initiate education programs of literature, films, and guest speakers with emphasis on avalanche safety and rescue.

*2 caught and buried***Weather Conditions**

A major snowstorm began at Crystal Mountain Ski Area on the evening of December 27. Snow fell continuously over the next several days; by the morning of December 30 a total of 36 inches of snow had been recorded. Heavy snow fell and strong winds, mostly westerly, blew on Wednesday the 30th. The upper mountain was closed because of high winds; all lifts were operating on the lower mountain.

Accident Summary

At about 1015 on the 30th, four young skiers caught the Quicksilver chairlift from the base area and rode to the top. They left the chairlift and skied to the left (east) toward an area called Boondoggle. This is mostly an intermediate area with skiing in the trees and on a partially cleared ski run. Above this run is a very steep, north-facing slope that is the Boondoggle avalanche path. This path is skied and runs infrequently.

The four skiers traversed onto this slope at a transition below the very steep upper section. Two of them skied downhill a short distance and then stopped to wait for the other two. Beth Johnson, 16, and Brian Berksted, 13, were still up on the slope; Brian was having trouble with his ski binding. On Brian's second fall, an avalanche released on the steep portion of the slope 200 feet above the two skiers. They were hit by the toe of the fast moving slide and were tumbled downhill for 10 or 12 feet and buried.

Both Beth and Brian were completely but

only shallowly buried. Both were able to clear the snow away from their faces and then dig themselves out.

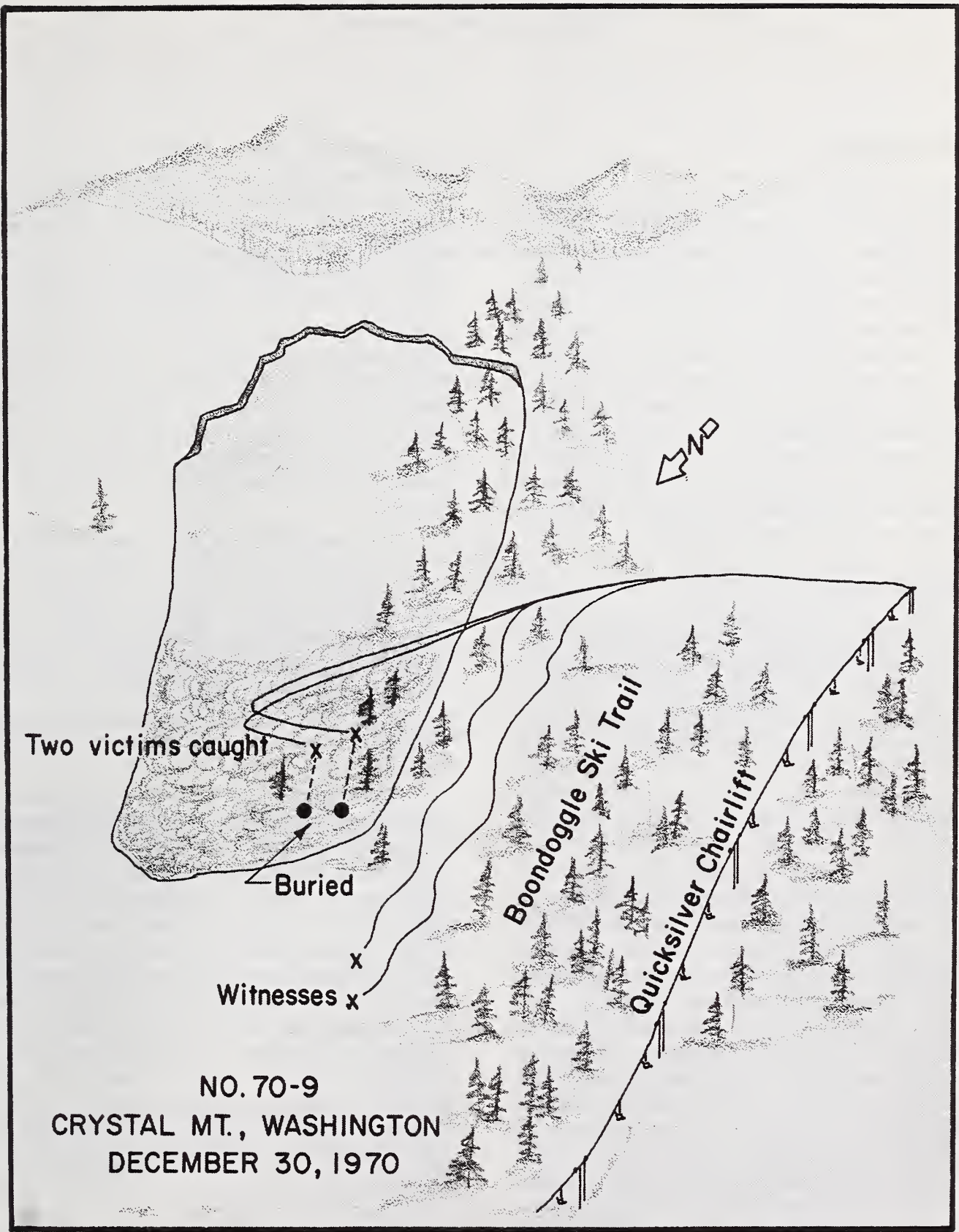
Their two companions who were waiting below had watched as all this happened. However, because of bad visibility they were unsure of what they saw. At first they thought the two skiers were being obscured by snow blowing off the trees, but soon realized it had been an avalanche. They walked back uphill to help their stricken companions. Brian had lost a ski in the slide; a search by the four skiers failed to find it. They then skied to the base area to report the accident to the patrol.

Avalanche Data

This avalanche was classified as SS-AS-2, fracturing 3 feet deep and running some 200 feet down the slope. The Boondoggle avalanche path is north-facing and portions of its starting zone are very steep—in excess of 40°. It runs infrequently, mainly because of heavy timber in the starting zone, and had not been controlled on the morning of December 30. This is normally considered a safe skiing area.

Comments

The two victims of this accident were struck by only the toe of the avalanche. This explains their being carried only a very short distance and their shallow burial. Following this accident, the area has been checked more closely for signs of instability. To insure safety, low-frequency avalanche paths in ski areas should receive the same attention as frequent ones.



NO. 70-9
CRYSTAL MT., WASHINGTON
DECEMBER 30, 1970

*2 caught, 1 partly buried***Weather Conditions**

Fifty-six inches of snow covered the ski slopes at Breckenridge on January 9; this included 9 inches of fresh powder from a recent storm. Preceding this storm, temperatures had been exceedingly cold, falling as low as -29°F on the morning of January 6. On Sunday the 10th, moderate but gusty winds were moving snow on the upper slopes and the temperature was 20°F . From the 5th to the 10th, wind direction was continually from the northwest. Avalanche control that morning had released one deep slide; thus, the uncontrolled slopes outside the ski area were considered unstable and touring was not recommended.

Accident Summary

By late morning on the 10th, all the powder snow at Breckenridge had been skied out. A group of seven skiers decided to head outside the ski area to find some untracked snow. They skied by the patrol building and inquired from two volunteer patrolmen who were standing outside whether an area called Cucumber was open. They were told it was and headed off.

Cucumber is located north of and beyond the ski area boundary and lies at the extreme northeast end of a wide bowl named Horseshoe Bowl. Avalanche control work is seldom performed in this area. Avalanche closure signs were posted on the normal route to Cucumber, but on this day the group chose a much higher route out of the ski area. Because their climb and high traverse bypassed the closure signs, the group unknowingly entered a closed area.

When they reached the first powder-filled gully, two of the skiers couldn't resist the temptation and jumped into it and skied it to the bottom. The remaining five—Eric Bell, Jim Hintschel, Mike Allen, Jim Wallace, and David Greer—continued toward Cucumber. Upon reaching their destination, four members of the group began hiking up toward the ridge crest while Greer skied down alone and waited at the bottom of Cucumber.

The four skiers began their traverse up and across a broad, open snowfield. Hintschel was in the lead and highest on the slope, Bell was slightly behind and below Hintschel, and another 10 feet behind and 15 feet below were Allen and Wallace. Suddenly the slope broke beneath their skis in a deep fracture with a muffled "whoomp" sound! Two sections of the slope began sliding away with one section catching Allen and Wallace. Between the two avalanching areas, a 50-foot-wide strip of snow fractured but did not slide. Hintschel and Bell were standing on this strip of the slab; the avalanche ran both in front of and behind them.

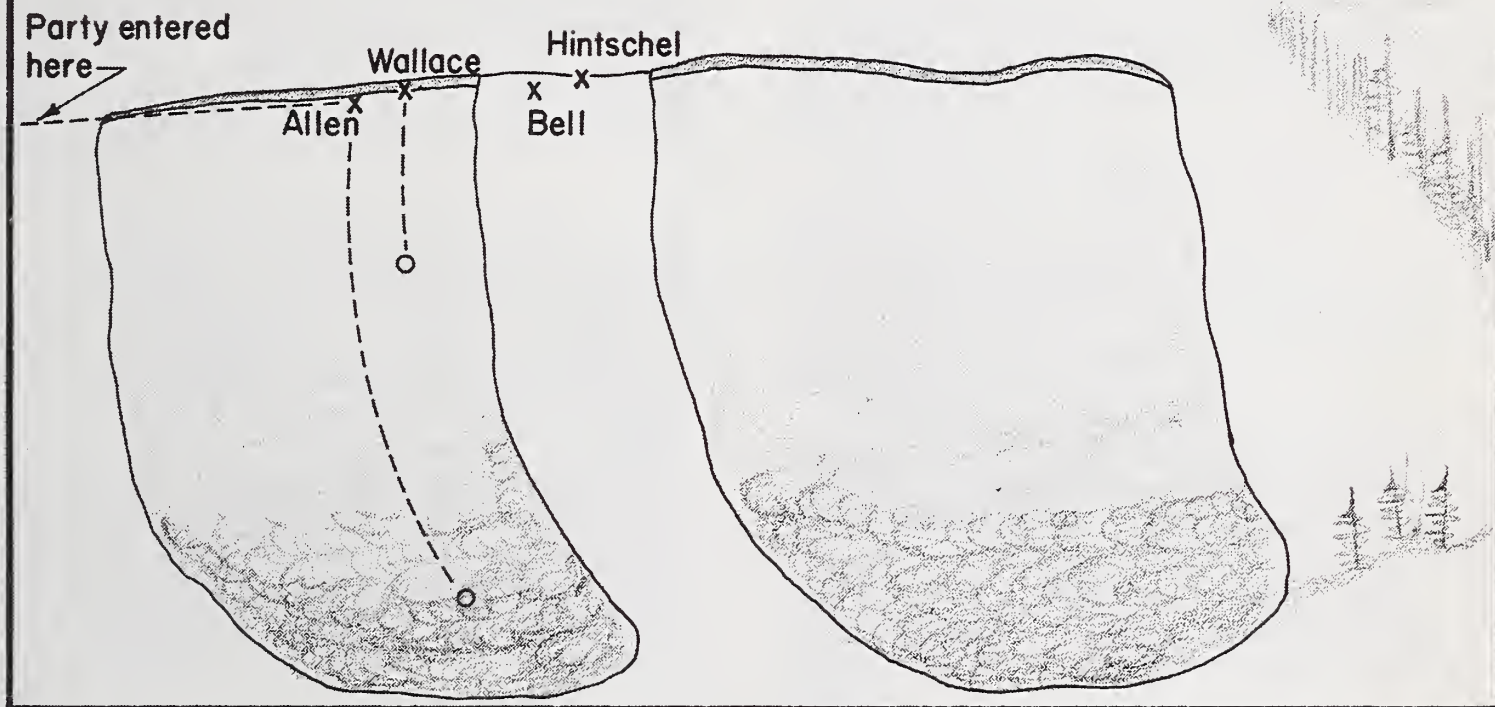
Wallace was standing right on the 4-foot-deep fracture line and fell into the void as the slab slid away. He slid down the bed surface about 80 feet before coming to rest on top of the uppermost debris. Allen, who was slightly lower than Wallace, was caught by the moving snow and swept 300 feet downhill; he was buried to the waist when the avalanche stopped. Wallace skied down the debris and helped dig out Allen.

Meanwhile, Hintschel and Bell were left standing on the part of the slope that did not avalanche. They were afraid to move and stood very still for fear of triggering the slab. The crack in the snow ranged from 2 to 10 feet uphill from their positions. As they waited, they could see that it was slowly widening. The two men talked over their situation and finally decided that Bell should ski straight down. He did so and reached flatter terrain where he was out of danger. Hintschel was left on the slope; he slowly worked his way to the edge of the slab, finally stepping to safety on the hard bed surface of the avalanche. The crack in the slab had widened to 6 inches by the time he got off.

Rescue

Around lunch time, two pro patrolmen skiing within the ski area saw two fresh avalanches in the Cucumber area. They made a short hike to view the slides better and then saw some skiers in the area, two of them stand-

NO. 71-1
BRECKENRIDGE, COLORADO
JANUARY 10, 1971



ing on a small strip of snow between the two avalanches. The patrolmen radioed headquarters and alerted them to prepare for a rescue; then the two men skied toward the accident site. When they got there, they found that everyone was accounted for and that Allen, the partly buried victim, was all right. The organized rescue was called off.

Avalanche Data

This avalanche, classified as a SS-AS-3, was triggered by the weight of the four skiers. The fracture line averaged 4 feet in depth and was 600 to 700 feet in length. Although the fracture line was continuous, the avalanche was split into two parts, leaving a 50-foot-wide strip of snow on the mountainside. The western half of the avalanche, the part that caught the two skiers, was about 200 feet wide; the eastern half, about 400 feet. Both slides ran more than 300 feet down the slope. The center

section of snow fractured and settled but was more securely anchored and did not avalanche.

Cucumber is a south-facing slope on the northern part of Horseshoe Bowl. The northwest winds of the 5 previous days had heavily loaded the slope. This slope of about 33° is not particularly steep and does not slide very often. However, in this case, in spite of its southern exposure, very cold temperatures had minimized settlement in the freshly deposited snow. The slab was highly unstable as evidenced by the depth and length of the fracture line. This was the first time this seldom-skied slope had avalanched this winter.

Comments

This accident might have been prevented with a little extra effort from both the ski area and the skiers. The problem partly arose because the volunteer patrolmen reported the area open when in fact it was closed due to

avalanche danger. Better communication between the pro patrol and the volunteers would have eliminated this piece of misinformation. Also an extension of the avalanche danger signs would have been seen and most likely heeded by these adventuresome skiers.

But a great share of the blame must remain with the skiers themselves. The party

made no attempt to inquire about avalanche conditions; a check with the pro patrol would have revealed that Cucumber was considered dangerous and was closed. It can only be assumed that this party never considered the possibility of avalanches. Continued efforts toward skier education seem to be the key to such accidents.

*1 caught, buried, and killed***Accident Summary**

Few details are available on this accident that occurred near Juneau on January 10. Greg Oxley, a young climber from Juneau, was climbing on Mt. Juneau above the city. Snow depths on the mountain ranged from 2 to 12 feet.

At about 1530, Oxley was climbing alone in an avalanche area called the Behrends Avenue avalanche, so named because it threatens residents of Juneau living on Behrends Avenue. Wearing campons, he was near the 2,700-foot elevation when he released a large avalanche which buried him under tons of snow. The slide was witnessed by several other persons, and a hasty search was organized. Probing was futile as the debris was 40 to 50 feet in depth. Oxley's body was not found until the following summer when it was uncovered by a bear near the 400-foot elevation.

Comments

A critique of this accident is not possible due to lack of details. It is sufficient to say that one of the hazards of winter mountaineering is avalanches, and these will continue to claim their victims.

It is known, however, that the fatal avalanche was the fourth to run down the Behrends Avenue path on this day. All four were large avalanches which threw up billowing dust clouds. The cause of this remarkable avalanche activity was a local wind phenomenon known as the Taku wind.

The Taku wind is a cold northeast katabatic wind which blows off the inland glaciers and is accelerated to incredible speeds: the wind screams over the ridgetops above Juneau at estimated speeds of more than 200 m.p.h. The avalanche starting zones are quickly loaded so that frequent and large avalanches are not uncommon when the Taku is blowing.

*3 houses and numerous miscellaneous facilities damaged***Weather Conditions**

The Wasatch Mountains of northern Utah were covered by a deep snowpack by January 1971. Extremely cold air invaded the region in early January, causing temperatures to fall to -22°F and colder. But on January 9 a rapid warming trend began with highs reaching into the midforties at Logan. Temperatures remained mild for mid-January even as a new storm moved into the region on the 11th. By the 14th, Logan had received 14 inches of new snow and higher amounts had fallen in the mountains east of the city. A heavy snow cover blanketed the steep walls of Logan Canyon just east of Logan. U.S. Highway 89 follows the Logan River along the bottom of the narrow canyon where numerous homes, buildings, and other facilities have been built.

Accident Summary

At 1830 on January 13, a large avalanche broke loose from the mountainside above the DeWitt Springs area in Logan Canyon. In the avalanche's path lay the city of Logan water works, the U.S. Forest Service Malibu Campground, and the highway. The water works was hit hardest by the avalanche. The building covering the springs was totally demolished as was the heavy fence surrounding the facility. Electrical power lines to the plant were also destroyed. The damage interrupted water service to Logan, forcing a switch to auxiliary sources.

The avalanche also struck a portion of the campground where it damaged facilities and destroyed trees and vegetation. The slide then continued toward the highway and ripped out 800 feet of telephone line. A car on the highway was struck a glancing blow and narrowly escaped disaster as the avalanche ran across the highway. Two hundred feet of guardrail was mangled as the avalanche covered the highway for 1000 feet in length and up to 25 feet in depth. The road was not cleared until 24 hours later.

On the following day, January 14, a large avalanche released above the Beirdneau

summer home development area where a number of homes had been built. The avalanche came down Beirdneau Canyon and reached the northern edge of the residence area. Two unoccupied homes lay directly in the path of the avalanche and were totally demolished. These homes, one a two-story structure, were both of wood construction and stood little chance against the force of the avalanche. A third house also built of wood, was hit a partial blow and suffered lesser damage. Two more avalanches released later the same day from side canyons and followed the same path as the first. Neither of these did any further damage; however, two deer killed by the avalanche were found in the debris.

Also on the 14th, an avalanche slid down Powder Hollow and struck a U.S. Forest Service powder cache. The cache was demolished and explosives were scattered over the snow.

Avalanche Data

Each of these destructive avalanches reached the canyon floor as a wet-snow avalanche. It is not known, however, whether they were wet slabs or hard slabs at the point of release. In any event, they ranged from medium to large and moved a considerable amount of snow down their tracks. All of these avalanches slide only infrequently.

The DeWitt Springs avalanche released at about the 7,000-foot elevation and stopped near the 5,000-foot level after traveling a distance of approximately 1 mile. The Beirdneau Canyon avalanche fractured at an elevation of nearly 8,000 feet and ran a distance of $1\frac{1}{2}$ miles, stopping at the 5,200-foot level. Three separate slides came down the walls of this canyon, the first one doing the damage. The Powder Hollow avalanche was channeled down a narrow ravine and hit the powder cache when the snow spread out at the mouth of the ravine. A similar avalanche in 1965 narrowly missed this same cache.

Comments

These avalanche damage incidents present a good case for avalanche mapping and

zoning. The low frequency of these slides adds to their danger in a subtle way: there is a tendency to treat them lightly and not give proper respect to their potential. This results in building permanent structures in avalanche paths where there is near-certainty that such structures will eventually be damaged or destroyed. Some mountain communities (for example: Ketchum, Idaho) have had the foresight to enact avalanche zoning ordinances.

Damage to the water works facility was estimated at \$10,000, and damage to the campground, telephone lines, and highway added several thousand more. The water works could conceivably be protected by an

avalanche diversion structure installed uphill of the facility. The building itself should be reconstructed with stronger materials.

The two destroyed summer homes had stood on the land for many years without incident; one was built in 1957 and the other in 1963. But the inevitable happened when a very large avalanche released in the canyon. The total value of the two demolished homes was \$22,000, and the lots they occupied were valued at \$2,850 each. The third house sustained \$1,000 in damages. Following this accident, the Forest Service recommended that no reconstruction of homes be allowed in this area.

The powder cache in Powder Hollow was rebuilt in an area safe from avalanches.

2 caught; 1 partly buried and 1 buried; 1 killed; 2 vehicles buried

Weather Conditions

The Pacific Northwest was on its way to a record snowfall season during the winter of 1970-71. By January 15, Paradise at Mount Rainier had already received 433 inches of snow for the winter and the depth of snow on the ground stood at 176 inches. Avalanches in the Cascades were falling in record numbers, prompting the Weather Service to issue avalanche alerts during the most intense storms.

Snow began falling over the Cascades on January 8 as a major and prolonged storm set in. By the morning of the 14th, Alpentel, near the summit of Snoqualmie Pass, had recorded a total of 37 inches of snow containing 2.63 inches of water. But on the 14th, snowfall intensity increased markedly to an inch an hour for much of the next 24 hours. Precipitation intensity exceeded 0.10 inch per hour for most of the next 18 hours. An avalanche warning had been issued by the Weather Service and was in effect for all mountain passes.

Accident Summary

Interstate 90, winding over 3,004-foot Snoqualmie Pass, is the major cross-mountain link between Seattle and points east. Avalanches threaten the highway on both sides of the pass. Two avalanche sheds, one on each side of the pass, were built beneath the paths that avalanched most frequently. However, these sheds cover only the two inside lanes of the interstate; the outside lanes remain uncovered. The east-side snowshed lies 6 miles east of the Snoqualmie Pass summit, and the eastbound lanes are exposed to avalanches running over the roof of the shed. A very large avalanche could conceivably carry a car off the highway and into Keechelus Lake.

At 2315 on January 14, a westbound motorist on I-90 reported a small avalanche had overrun the east snowshed and had caught a car in one of the eastbound lanes. A highway department employee drove to the shed and picked up the stranded driver, Tom Taylor. To prevent eastbound traffic from entering the slide area, they posted themselves on the

highway ahead of the slide area. The highway foreman then arrived and asked Taylor what he wanted to do about his car. He said that he would like a wrecker to pull him out so he could be on his way. The wrecker was called at 2346. Snow continued to fall hard.

In the meantime, two snow blowers arrived to clear the snow from the highway. The state patrol had arrived and was directing traffic when the wrecker arrived. The wrecker hooked up to Taylor's car and pulled it free of the snow. The wrecker with Taylor's car in tow then pulled forward some 20 to 30 feet and stopped—still beneath the avalanche path.

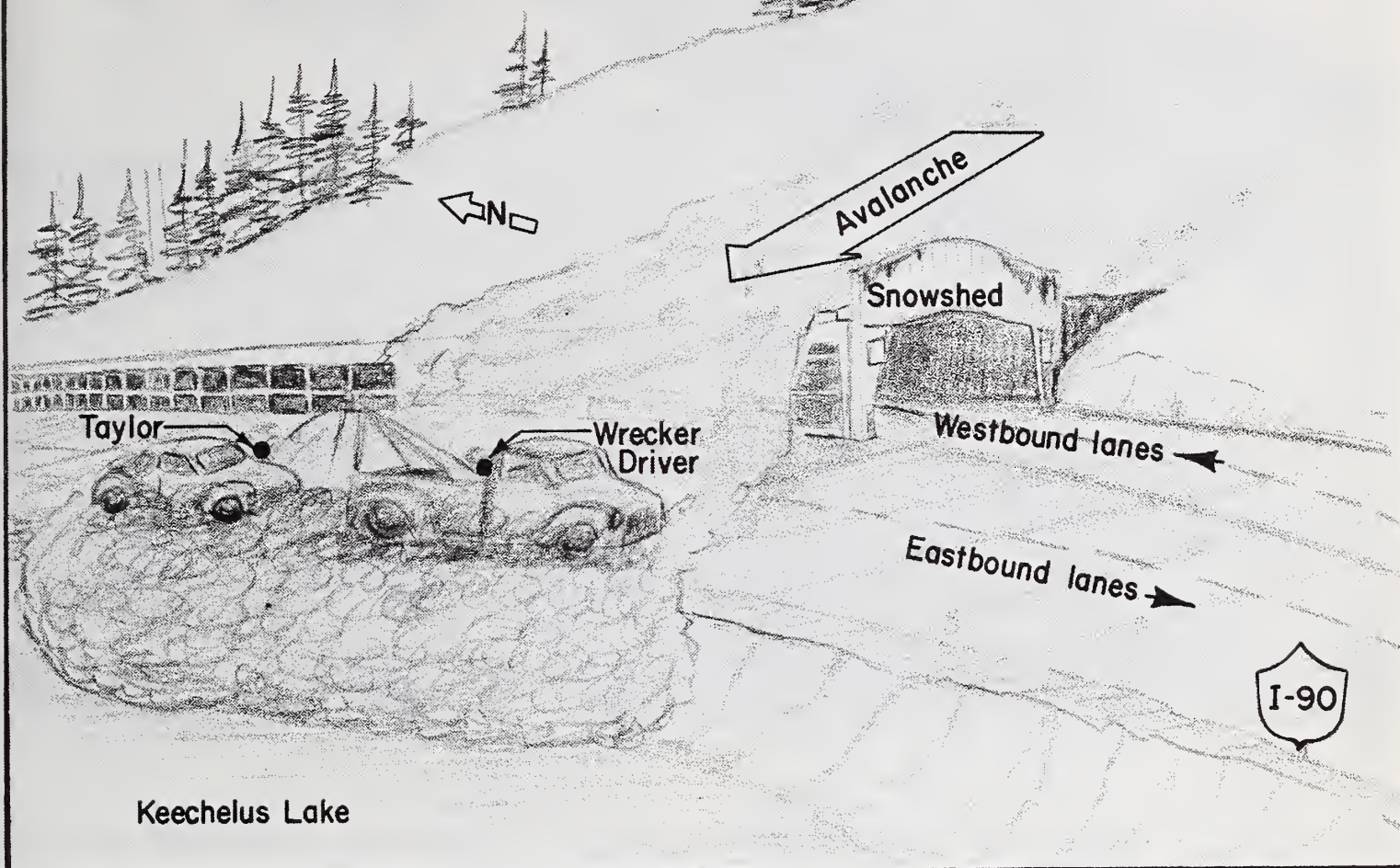
The time was 0020 in the morning of the 15th when the wrecker driver unhooked the car and both men prepared to drive away. At that moment, another avalanche released on the mountainside above and came hurtling over the snowshed. The two men had only an instant to react; the wrecker driver dove under the wrecker and Taylor tried to get inside his car. Then the avalanche struck, totally burying Taylor and his car. The wrecker was only partly buried, but the driver could not be seen beneath it.

Rescue

After the avalanche stopped, there were four men—three highway department personnel and one state patrolman—immediately on hand to initiate the rescue. They began digging by hand under the partially buried wrecker and found the driver. He was completely buried except for his face and hands which were fortuitously sticking out of the snow beneath his truck. The driver was dug out at 0030 and all efforts were turned toward finding Taylor.

According to the wrecker driver, Taylor's car was sitting close behind the wrecker when the slide engulfed everything. The wrecker was moved out of the way and a snow blower and front-end loader were brought in quickly to locate the car. The car was found within minutes by the snow blower, and the rescuers then began tunneling in with shovels.

NO. 71-4
SNOQUALMIE PASS, WASHINGTON
JANUARY 15, 1971



At 0120, Taylor was found wedged between his car and the open left door. The snow was tightly compacted around him. Although revival efforts were tried, he was dead from suffocation. Buried for 1 hour, the victim had no chance finding enough air beneath the dense debris. Because of the danger of a third slide (which in fact occurred), the car was not removed until daylight.

Avalanche Data

Two avalanches ran down this path in about 1 hour's time. The first was a SS-N-2 and trapped Taylor's car on the highway; the second was a SS-N-4 and deposited snow 10 feet deep on the highway. Both slides were reacting to an intense current snowfall. The second and larger slide ran a distance of 1500 feet, was 300 feet wide, and easily overran the snowshed, cascading onto the highway.

The slope on which these avalanches ran is west-facing and has a steepness of 45° in the

starting zone. The path is lightly timbered and avalanches frequently.

Comments

The east-snowshed avalanche on Snoqualmie Pass has a particularly infamous history of burying eastbound traffic on I-90. An earlier accident occurred here in 1966 (see *The Snowy Torrents* No. 66-2) and another in March 1972. Because the snowshed covers only the inside lanes of the highway, fully 50 percent of the I-90 motorists have no protection from this frequent-running avalanche.

This accident is also one more example of the danger of avalanche paths that strike twice in a short period of time. Accidents of this nature are common, as exemplified by Nos. 69-16, 70-4, 70-6, and 71-10. Rescuers should take heed and plan accordingly: spend only as much time as is needed working beneath the avalanche and no more; and post an avalanche guard when feasible.



No. 71-4. Snoqualmie Pass, Washington. I-90 snowshed 6 miles east of the summit of Snoqualmie Pass. The avalanche flowed over the roof of the shed and covered the unprotected eastbound lanes of the highway.

3 caught; 1 buried and injured

Weather Conditions

From January 9 to 15, 63 inches of snow were recorded at Crystal Mountain Ski Area, increasing the total snow depth to 91 inches. On the 15th, a warming trend set in and light rain began falling at elevations of 6,000 feet and lower. With the rain came intense west winds averaging 40 m.p.h. and gusting as high as 94 m.p.h. The combination of snow, rain, and wind increased the avalanche hazard to high levels.

Avalanche control was carried out daily in the ski area with little results until the 15th. On that day, class 3 and 4 avalanches began to occur, some running naturally. Friday the 15th was very windy, too windy to run Chair No. 2 which would carry the control teams to the top of the mountain. The lower 75-mm rifle was fired blind, but most of the results went unobserved because of heavy fog and clouds. One large avalanche was heard as it snapped trees on its descent down Exterminator. Only part of the ski area was opened on the 15th.

Accident Summary

Saturday morning, January 16, dawned clear with considerably less wind. At day-break, avalanche control began in earnest. Snow Ranger Lloyd McGahuey describes the day's activities and the accident in the following narrative.

"At 0600, my assistant Ray Baker and I left for the mountain. There we met members of the Crystal Mountain pro patrol along with two volunteer patrolmen. We discussed the plan of action which was to control Exterminator and Snake Pit before opening Chair No. 1. Ray and I fired the midway rifle.

"We then met on top of the mountain to gather our explosives for the trip to Angle Ridge to control the chutes over the housing area. We arrived over the area at the appointed time and checked by radio below to the housing area to determine if all was clear. After several hand charges had released one small slide, we determined that the area was safe; it had already slid out the day before.

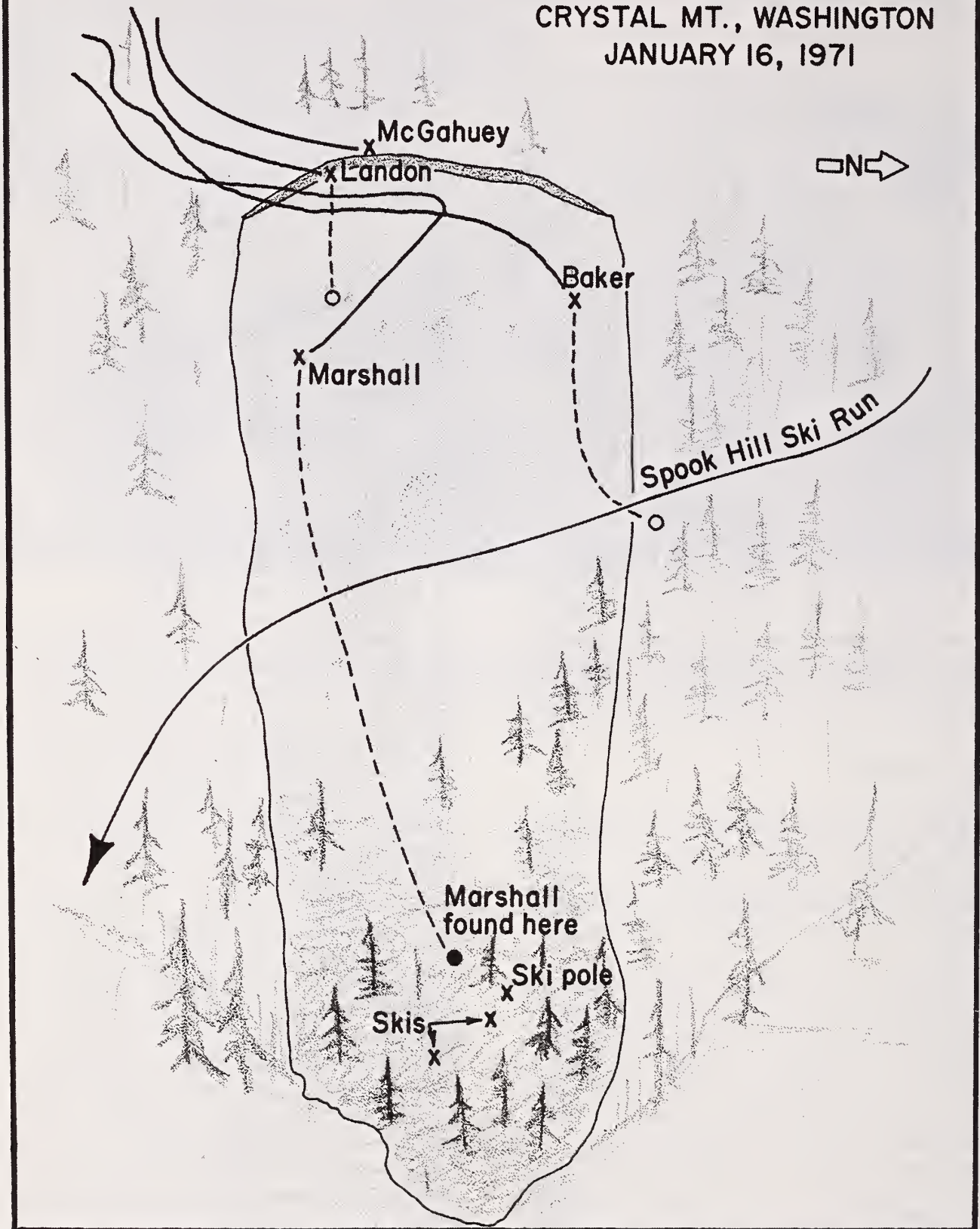
"Ray and I fired the Angle Ridge avalanche rifle into Brand X area while Jerry Landon, a volunteer patrolman, and Mike Marshall, a pro patrolman, observed and took pictures. We knocked down one large avalanche out of Pucker Gulch that ran a quarter of a mile down the Northway Trail. After cleaning the rifle, we skied down under the Niagara Chutes to check action. We found them all clean and safe. We then headed for the last chute which overhangs the lower Spook Hill run.

"We arrived there at 1155. We paused for a moment while we waited for Jerry. He was having trouble with a ski binding. We discussed control of the chute. We probe-tested the snow and determined that it had slid previously. There did not appear to be much snow in it. We decided to ski it out.

"Ray skied across the chute and side slipped about 25 feet down the opposite side and stopped. Mike skied out, kick turned and side slipped about 50 feet down the other side. I skied out to the top-middle and again tested the snow; it appeared to be okay. Jerry came out behind me. Suddenly the whole mountain seemed to move, at first almost in slow motion. The fracture opened up under Jerry's skis; he fell down the path about 25 feet. Ray and Mike started down with the avalanche. Mike's skis were pointed downhill, he was skiing down with the slide but appeared motionless relative to the moving snow. After 150 feet, Ray scrambled out to the side. We both watched Mike gathering speed with the avalanche; he seemed caught in a giant vise. The avalanche narrowed and went over a knoll; there was a large white cloud and Mike disappeared. I cannot tell you all the things that went through my mind during this instant. I was left high and dry. It had broken about 4 feet below me. Ray skied down the slide path calling Mike's name with me right behind him. Jerry was back on the path with a broken binding.

"As soon as Ray and I reached the last point at which Mike had been seen, we saw the avalanche had run another 200 feet onto a flat area. All was quiet and white. No Mike! Jerry was carrying the radio, so we immediately set

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the rescue operation into high gear. I gave directions on how to get there, gave instructions to send all available manpower, and ordered search and rescue dogs, a doctor, a toboggan and an ambulance.”

Rescue

“While waiting for the hasty search party to arrive, I studied the slide to determine flow and then looked for clues. Fifty feet up from the bottom, I found one ski pole and 5 feet below that I found one ski; another 25 feet below that I found the second ski. Ray and I along with Jerry probed the area with our ski poles. We then searched likely areas where a body could lodge. The avalanche occurred at 1205; at 1305 the hasty search crew arrived led by Gordon Burlingame with six patrolmen.

“I put them to work probing likely spots. After about 10 minutes, I took them and formed a probe line where we had found the lowest ski. After 10 minutes, Endrik Noges and eight more people arrived, and I appointed Endrik as probe-line leader and we put all the men on the line. After 10 minutes and about 50 feet of probing, Jack Hadfield cried, ‘I hit something.’ The shovelers started digging. The probe line continued on. The something proved to be Mike. As soon as his face was uncovered, he started hollering. What a beautiful sound! This was at 1335, exactly 1½ hours from the time the avalanche was triggered. Mike was found in a prone position, head downhill with one hand by his mouth and nose. His mouth and nose were free from snow. At this time Dr. Krenge~~t~~ arrived and shortly after that, more follow-up crews and the toboggan.

“The snow was carefully removed from around Mike so that the toboggan could be moved in on a level with him. He complained about pain in the pelvic region and his legs. He was immobilized as he was put into the back splint and then was moved into the toboggan. Mike was in the ambulance and away at 1430.

“In addition to being in deep shock, Mike’s injuries consisted of a broken leg, both bones, just above boot top, a cracked pelvis and his hip socket was jammed from the force, possibly causing the pelvis fracture. Mike says that he is thankful and that his life could not have been entrusted to a better bunch of people.”

Avalanche Data

This avalanche was classified as a SS-AS-3 and was triggered by the four members of the control team. The snow fractured directly under the skis of Jerry Landon, who then fell into the 3-foot-wide void when the slab moved out. The avalanche had characteristics of both a wet and a dry avalanche; it grooved the bed surface in places but also threw up a dust cloud after dropping off a knoll in the path. Skiing conditions in the area were described as ‘mashed potatoes’.”

The slope was a lightly timbered, northeast-facing path with a steepness of 35° in the starting zone. The avalanche started at the 4,900-foot elevation and dropped to 4,450 feet. The upper part of the slide path is a rock slide; it then flows over a knoll into the runout zone which is covered with numerous trees. The debris was as deep as 8 feet in this area.

Comments

The victim was fortunate to have survived this ordeal. He was buried under 4 feet of heavy snow, lying in a prone position with his head downhill. He had been able to get one hand close to his nose and mouth, keeping them free from snow or obstructions. The pole straps were off his wrists and no safety straps were worn on his skis. All ski equipment had come off and this may have helped him get his hand into position.

His body position, however, was not favorable. The prone body position and his severe injuries resulted from hitting a tree. Marshall vividly remembers being swept directly into a tree, hitting it with full force. He was then thrown forward onto his stomach and face and was helpless to improve his position.

This kind of accident is apt to happen to any avalanche worker during his career. Control skiing leads to numerous minor accidents and a few severe ones each winter. In this accident, both of the U.S. Forest Service skiers were carrying Skadis, but the two ski patrolmen were without. A rescue within minutes would have been the result if Marshall had had a Skadi. Skadis (or any of the other avalanche rescue beacons) are strongly recommended for all avalanche control personnel.

2 caught; 1 partly buried and injured

Weather Conditions

During the period of January 10 to 17, 44 inches of snow containing 4.35 inches of water had fallen at Sun Valley Ski Area. The total depth at the ski area increased from 58 to 79 inches.

Accident Summary

On January 17, Ruth Murray and 15-year-old Mike LeBarron were driving along U.S. Highway 93 near Ketchum, Idaho. Four miles south of Ketchum, they stopped their car to photograph some deer. While climbing a steep, snow-covered hillside near the highway, they triggered a small soft-slab avalanche. The time was about 1400. LeBarron escaped unharmed, but Murray was swept rapidly downhill; she was only partly buried but had suffered a badly broken leg. The Sheriff's Department in Hailey, Idaho was notified of the accident at 1442. An ambul-

ance quickly reached the scene and took the victim to the Sun Valley Hospital.

Avalanche Data

Numerous avalanches had recently occurred in the general area, all reacting to the recent heavy snows. The slope on which the accident occurred had avalanched naturally only a day or two earlier.

Comments

Although only scanty facts are available, this accident still has a moral: when snow conditions are unstable, one does not have to travel too far to get into trouble. These unsuspecting adventurers had traveled only a short distance from their car before becoming avalanche victims. As is true of so many accidents in this volume, public education is the key to reducing the number of accidents of this nature.

*1 caught, buried, and killed***Weather Conditions**

The U.S. Forest Service Ranger Station in Fairfield, Idaho reported a total snow depth of 38 inches on January 15. The following day mixed rain and snow began falling; the day's total for the 16th was 6 inches of wet snow which held 0.82 inch of water. A total of 1.23 inches of rain fell on the 17th and 18th. By January 20, the storm had ended, the skies were clear, and the snowpack had settled to 24 inches. Avalanche warnings for the Sawtooth National Forest had been broadcast on January 14, and this warning was still in effect on the 20th.

Accident Summary

On the morning of January 20, a party of snowmobilers were enjoying a day's outing along Willow Creek, 15 miles east of Fairfield. They were on private land and were driving their machines on the hillsides on both sides of the creek. At 1215, Bill France got his machine stuck in the heavy, wet snow about a third of the way up a steep pitch. John Sabala was at the creek bottom and Gary Osborne was on the opposite hillside at the time.

As France was trying to dig his machine out, the snow fractured about 200 feet above him—about 30 feet below the ridge crest. France had no chance to move and was overwhelmed by the heavy snow. Sabala was at the bottom of the slope and had time to escape the fairly slow avalanche by going up the opposite hillside.

Osborne viewed the entire accident from the opposite side of the creek. The avalanche ran to the creek bottom and stopped. France's snowmobile was pushed ahead of the slide and came to rest on top of the avalanche, but there was no trace of France. The men briefly searched the area but could find no clues; then one of them left to bring additional help.

Rescue

The Camas County Sheriff's Department

and the Soldier Mountain Search and Rescue unit both responded to the call for help. But several hours had passed before the rescuers were on the scene and a probe line established. Finally at 1615, 4 hours after the accident, the body of Bill France was found by probers. He was found 50 feet downhill from where he had been struck and was buried beneath 9 feet of snow. Suffocation had obviously come within minutes of being buried.

Avalanche Data

This was a medium-size, wet-slab avalanche that was released by a snowmobile and its driver. The fracture line was 2 feet deep. The snow ran 300 feet down the slope—a vertical distance of 163 feet. The total avalanche area was approximately 3 acres and all of it slid on an old ice layer. The snow was heavy and wet from the rain that had fallen 2 days earlier.

This part of Willow Creek lies at an elevation of 5,600 feet. The avalanching slope has a northeast exposure and a steepness of 33°. The slope is completely bare of trees and the sagebrush ground cover lay well beneath the snow surface at the time of the accident. There was no previous history of avalanches on this slope.

Comments

There were no reports of this slope having avalanched for at least 40 years; yet it possessed, under the right conditions, all the characteristics of an avalanche slope. A deep snowpack covered all the vegetation, and recent snow and rain had heavily loaded the slope. The slab failed under the additional weight of a snowmobile. This snowmobile party had not heeded the recent avalanche warning, evidently thinking that they were not traveling over avalanche terrain.

The victim would have probably died even if he had been quickly found by his companions. The necessity of sending for outside help sealed his doom. Under such a depth of heavy, wet snow, life is measured in a few short mi-

nutes. During extreme avalanche conditions, anyone near the floor of a V-shaped canyon is in a highly vulnerable position. Any avalanche

that releases above him will bury him hopelessly deep as the snow fills the canyon bottom.

16 caught; 13 buried; 4 injured; 4 killed. 7 cabins damaged

Weather Conditions

The Cascades were in the midst of their most severe winter in many years. Snowfall had been heavy with record snow depths accumulating in some areas. By mid-January, more than 100 inches of snow covered the mountain slopes around the Stevens Pass Ski Area. Precipitation was recorded on 20 consecutive days between January 8 and 27 at Stevens Pass with daily water amounts ranging from a trace to 2.90 inches.

A major storm that would lash the area for 6 days began on January 20. At Stevens Pass, the precipitation occurred as follows: by 0800 on the 21st, 14 inches of snow containing 1.57 inches of water had fallen; on the 22nd, 12 inches of snow, 1.33 inches water equivalent; on the 23rd, 9 inches of snow, 1.14 inches water equivalent; and by midnight on the 23rd, 14 additional inches of snow with 1.50 inches water equivalent. All during this period the winds were westerly and averaged 30 to 45 m.p.h. without letup. The anemometer stopped operating on the night of the 23rd, and no more wind readings were possible for the remainder of the storm.

Accident Summary

Yodelin is a private development of "second" homes which lies along U.S. Highway 2 just east of the summit of Stevens Pass. In 1968, construction began on several cabins at the foot of a steep, east-facing mountain-side. The cabins of Barton Edgers and Milo Stoen sat side-by-side at the foot of this slope; both were two-story cabins.

On the weekend of January 23 and 24, there were 16 occupants in these two cabins. In the Edgers cabin were Mr. and Mrs. K. Barton Edgers, 43 and 41; their children, Deborah, 19, and Cindy, 14; Mr. and Mrs. Billy G. Lewis; and their children, Kenneth, 10, Mark, 8, and Richard, 5. In the Stoen cabin were Mr. and Mrs. William Dean; their children, Linda, 15, Nancy, 14, Peggy, 12, and John, 8; and a friend, Judy Hewlett, 12.

The storm was still raging when the resi-

dents of the two cabins went to bed on Saturday night (January 23). Near midnight on Saturday, or in the early morning hours of Sunday (the 24th), an avalanche released above the cabins and struck them full force. The Edgers cabin was demolished; it was ripped from its foundation, and pieces of walls, roof, and boards were carried more than 100 feet downhill. The Stoen's cabin was engulfed with snow crushing the back wall and roof and filling the upstairs bedrooms. A third cabin—this one unoccupied—was also struck; the rear wall buckled and snow spilled into the living room. Residents of neighboring cabins were unaware of the disaster until survivors from the Stoen's cabin came calling for help.

Rescue

A resident and developer-owner of Yodelin, Wendell Carlson, was one of the first persons alerted by the survivors. Within minutes Carlson had notified the Yodelin Ski Patrol, the Stevens Pass Ski Patrol, the Chelan County Sheriff's office, the Leavenworth Volunteer Fire Department, the State Highway Department, and the U.S. Forest Service. The Yodelin patrolmen were the first rescuers on the scene. With the help of William Dean, who had escaped from the slide, they began searching the upstairs rear bedroom of the Stoen cabin in which Peggy Dean and Judy Hewlett were sleeping. The room had been completely filled with snow. After a short period of digging, both girls were found. Both were unconscious, and mouth-to-mouth resuscitation and external heart massage were immediately administered. The Hewlett girl responded and was revived within minutes. Peggy Dean did not respond in spite of being worked on for several hours. She was finally pronounced dead, a victim of suffocation. All the other occupants of the Stoen cabin survived without injury.

Meanwhile additional rescuers began searching the wreckage of the Edgers cabin for survivors or bodies of the dead. The broken sections of the house were completely buried beneath the snow, but probing soon revealed the wreckage of the upper story. Voi-



No. 71-8. Yodelin, Stevens Pass, Washington. The photograph on the left is an aerial view of part of the Yodelin development on December 20, 1968. Note the three cabins circled. The photograph on the right is an aerial view of the same area taken on January 28, 1971, four days after the accident. Note that within the circled area many trees and the rightmost cabin are missing. These were destroyed by the avalanche.

ces could be heard beneath the debris, but clearing the wreckage with shovels, chain saws, and axes was slow work.

After cutting through the roof, the rescuers came across the Lewis family who had been sleeping upstairs. Mr. and Mrs. Lewis were found alive after being buried an hour and a half, jammed in their sleeping bags under a heavy beam of the cabin. This beam had supported the roof above them, giving them a breathing space and saving their lives. Minutes later their son Mark was found alive, but 10-year-old Kenneth was removed from the wreckage, dead from suffocation. Richard Lewis was still buried somewhere in the ruins.

It was from Lewis that the rescuers learned that nine persons had been in the cabin and that all four members of the Edgers family were unaccounted for. Mr. and Mrs. Edgers had been sleeping upstairs and the Edgers girls had been sleeping on the lower floor. Digging through the wreckage soon produced the bodies of Mr. and Mrs. Edgers, both dead from suffocation. They were found only 8 feet away from where the Lewises had been rescued alive.

The rescue continued throughout the night with a portable gasoline generator from Stevens Pass providing light for the searchers. An avalanche guard had been posted to warn the rescuers in the event of another avalanche. In addition, the occupants of six or seven other cabins in the area were evacuated from their homes.

By dawn, the number of rescuers had thinned out as most of the ski patrolmen returned to their jobs and the volunteer firemen returned to Leavenworth. Less than a dozen men remained at the disaster site. It had been several hours since anyone had been pulled from the wreckage, and the rescuers felt little hope of finding anyone else alive. Already, four lifeless bodies had been taken out. Three victims—Richard Lewis and the two Edgers girls—remained buried somewhere beneath the tangle of snow, lumber, and household goods.

A bulldozer was brought in after daybreak to remove some of the debris. But it wasn't until about 1030 that one of the rescuers heard a sound in the same area that the Lewises were found. Minutes later 5-year-old Richard Lewis was pulled out from under a section of the roof. He had been buried for 10 hours and was suffering from hypothermia and shock, but was otherwise in good condition.

Finding this boy alive renewed the hope

that others may have survived. The two remaining victims had been sleeping on the main floor of the cabin and as yet this had not been found. The rescuers devoted all efforts to digging down to this level.

At noon, a sound was heard as another section of cabin was uncovered; soon a small dog was dug out—frightened and half frozen, but alive. Shortly, when the front door and porch were uncovered, the position of the two Edgers girls could almost be pinpointed. But this necessitated digging about 10 feet into a 15-foot-high wall of snow. At 1300, voice contact was made with the girls. They were still alive!

It took another half hour of digging to break through to where the girls were pinned under a section of the back wall. The wall had collapsed over their bed but had also shielded them from most of the snow and allowed a small breathing space. After being buried for more than 12 hours, Debbie and Cindy Edgers were pulled, frightened but unhurt, from their prison of snow.

Now that all the victims had been found, the rescue was concluded. The area was then evacuated for fear of more avalanches. All the survivors, some of whom were injured, were taken to the hospital in Wenatchee for treatment and observation.

For the victims who escaped alive, the experience was harrowing. As the avalanche struck, Mrs. Lewis said she heard a rumbling and a crackling sound; Mr. Lewis recalled only being squeezed. They were jammed in their sleeping bag under a beam of the cabin in a cramped, yoga-like position. Lewis had one arm free and could even touch his children. He remembered it being very hot and having to search for snow to put on their faces and in their mouths.

Downstairs in the same cabin, Deborah and Cindy Edgers had been sleeping in a roll-out double bed when the slide hit. Debbie said she first realized what had happened when her sister started screaming. The wall had caved in, falling over the rigid headboard and forming a kind of tent. There were triangular openings at each end and a cool breeze came through. Debbie remembered waking up and feeling around. It was cold and the snow had enclosed them all around. She could move a little, and Cindy could move except for one of her legs which was pinned.

Shortly after the avalanche struck, Debbie heard a child cry out—probably one of the Lewis children; she also heard her dog whimpering. Both girls were in their bedclothes and

were fairly comfortable at first; then it started getting damp. The snow began to settle and confined them more and more, but it was still warm in the enclosed space. Eventually they heard the sounds of searchers working above them and the vibration of tractors. They called out and pounded on the wood, but they didn't think they would be found in time. But when the rescuers finally broke through to them, both girls burst into tears when they realized that they were going to be okay.

Avalanche Data

There appear to have been two distinct avalanche cycles in the Stevens Pass area. The first cycle began on January 22 and ended on the 25th and was mainly made up of soft-slab avalanches. These were in response to the heavy snowfall, strong winds, and continual below freezing temperatures during the period of January 21 to 25. The second cycle occurred on January 26 and 27—after the Yodelin tragedy—and consisted of wet-slab and wet, loose avalanches too numerous to count. These were induced by warmer air and rain marking the end of the storm which had begun on January 20. Many of these wet avalanches ran on top of dry avalanches of the first cycle.

The Yodelin avalanche occurred during the first cycle and was a natural soft-slab avalanche (SS-N-3). Approximately 300 feet wide, it ran about 700 feet vertically and had an estimated 3-foot fracture line. This east-facing slope has a steepness of 40° in the area where the avalanche released. Trees of more than 1 foot in diameter were bent over or snapped off by this slide. About the same time as this avalanche, another slide struck and damaged the chapel at Yodelin, several hundred yards from the destroyed cabins. In all, six slides were observed on the Yodelin slope. The following day (January 25) a large slide came off Lichtenberg Mountain to the north of the development. This slide rode over a bench part way up the mountain and continued down the slope, striking three additional cabins in the Yodelin development. Two of these were totally demolished and the third was severely damaged. None were occupied; however, one had been evacuated only the day before.

Comments

No case can better exemplify the need for avalanche zoning than this one. The toll in this tragic accident was 13 persons buried, 4 injured, 4 killed, and extensive loss of property. A strong zoning ordinance would have prevented these cabins from being built. This accident was not the result of a "freak" avalanche, for the area has an established history of avalanches. In February 1910, the area was swept by avalanches that killed two men; this was during the same cycle that produced the Wellington train disaster just a few miles away on the opposite side of Stevens Pass (see *The Snowy Torrents* No. 10-1). Then in 1948 a large avalanche came down the Yodelin slope and crossed both Stevens Creek and the highway. This was a much larger slide than any of those occurring in January 1971.

Concern about the avalanche hazard in the area was first voiced in 1966 and again in 1968 when construction began in the development. Nevertheless, lots continued to be sold and homes continued to be built beneath the steep slopes.

Even before the tragic slide of January 24, the homeowners at Yodelin had been alerted to possible danger. In the spring of 1970, a small slide had come through the back door of the Edgers cabin, spilling considerable snow into the kitchen. And earlier in the winter of 1970-71, the cabin had been struck again. These experiences had caused Mr. Edgers to run a cable from the main floor to a large rock behind the cabin to keep it from being moved off its foundation. The back windows and door were also boarded up for wintertime use. These precautions are a classic underestimation of the destructive forces involved. Apparently, only one family at Yodelin heeded the warning signs and left for the winter.

So the key to preventing future accidents of this kind is twofold: avalanche zoning and public education. In the absence of strong zoning regulations, the buyer must be made aware of the avalanche threat in mountainous terrain. In the aftermath of the Yodelin disaster, lawsuits were filed by the survivors of the accident against the developers of Yodelin. One suit has been settled out of court; another is still pending.

1 caught, buried, and injured; 1 vehicle buried

Weather Conditions

The weather conditions contributing to this accident are described in No. 71-8. Heavy snow continued to fall all during the day on January 24. While the rescue was in progress at Yodelin, numerous avalanches hit the Stevens Pass Highway (U.S. 2) blocking both the east and west sides of the pass.

Accident Summary

A highway crew was sent to the Tunnel Point area on the west side of Stevens Pass to clear avalanche snow that was blocking the highway. Two gullies of the Old Faithful slide area had released and covered the road up to 30 feet deep for a length of several hundred feet. Casey Watson and Verl Lyon were both operating front-end loaders as other men worked the debris with cats.

At about 1230, another gully of the Old Faithful group released its load of snow. The avalanche rushed out of the gully and onto the highway where it missed Lyon and his machine by only a few feet. Watson, however, was not so fortunate; the avalanche hit him full force and pushed his heavy machine across the road and up against the guardrail. The rail held, preventing the driver and machine from being swept into the canyon below. Though spared the ordeal of being tumbled down the embankment, Watson was still buried completely by the avalanche.

Rescue

The other men at the scene rushed to the rescue. They dug frantically through the snow and uncovered the cab within minutes. Snow had broken the windshield and filled the cab and was so tightly packed that Watson was unable to move. He was removed from the cab

suffering from a back injury. He was taken by ambulance to the hospital in Monroe for treatment.

Avalanche Data

The Old Faithful avalanche area consists of a series of gullies that run with almost every storm and collectively hit the highway scores of times each winter. The avalanches slide down a west- to northwest-facing slope having a steepness of 38° to 40°. Avalanches starting at the top of this slope drop some 1200 feet vertically before hitting the highway; the larger slides then sweep across the road to drop another 400 feet to the Tye River. More than 1 mile of the highway is affected by the Old Faithful avalanches. These avalanches reputedly got their name in 1943 when three separate gullies ran precisely at 1-hour intervals.

These slides are controlled by a 105-mm rifle, but it was a series of natural avalanches that caused this accident. These were classified as SS-N-3 and SS-N-4.

Comments

U.S. Highway 2 was closed during the 5-day period of January 24 to 28 because of avalanches resulting from the continuing storm. The highway crews faced a major cleanup effort—and continuing avalanche peril—but managed to reopen the highway on the 28th.

While the storm raged on January 24, the avalanche danger was extreme. Whenever possible under such conditions, avalanche paths should be controlled with artillery before sending a work crew into the avalanche area. Highway crews take the greatest risk of all and are deserving of all the help they can get.

1 caught, buried, and injured; 2 vehicles buried

Weather Conditions

As described in No. 71-8, 35 inches of snow had fallen from January 20 to 23 in the Stevens Pass area of the Cascades. On the morning of the 24th, 20 more inches of snow covered the ground, and by the 25th an additional 26 inches had fallen. The snowfall over these 49 hours contained a full 5 inches of water equivalent.

Accident Summary

At about 1900 on January 25 a soft-slab avalanche released in an old clearcut area (above and south of Tunnel Creek and U.S. 2) several miles west of the summit of Stevens Pass. Directly in the path of the avalanche was a tower supporting high voltage powerlines. The tower was sheared off and fell to the ground, leaving the 345,000-volt lines intact but suspended ticklishly in the air.

A crew of about 10 men was sent by the Bonneville Power Administration (B.P.A.) into the area on the night of the 25th to restore the tower or secure the high voltage cable in some manner. As the crew was working in the darkness to clear the debris, another avalanche released above them. An unoccupied D-9 cat was hit hard and buried by the slide. A D-8 cat and its driver were also in direct line of the avalanche. The machine was struck, pushed downhill, and completely buried. The slide narrowly missed the remaining crew who were quick to come to the rescue of the buried driver.

It took several minutes before the buried cat was located beneath the mass of snow and several more minutes to dig down to the cab. After a burial of about 20 minutes, the driver was pulled from the snowpacked cab; he had received only minor injuries.

Avalanche Data

This avalanche was a SS-N-4 that fell some 1000 feet vertically down the untimbered slope. This slope faces north, has a steepness of about 37° near the top, and was the site of a clearcut sometime in the past. The first avalanche, the one that destroyed the powerline tower, was the largest of the two avalanches; it fell about 1600 feet vertically and moved a large volume of snow.

Comments

This was the third avalanche accident in 2 days in the immediate Stevens Pass area (see Nos. 71-8 and 71-9). Avalanches too numerous to count resulted from the intense storm, and multiple avalanches on any given slope were common. Avalanche hazard had reached critical proportions when the B.P.A. work crew entered the avalanche zone to perform the necessary tower repairs. Explosive control should have been used on the open slope above to protect the work team. After the second avalanche struck and buried one man, the task was wisely postponed until more stable snow conditions developed.

*1 bridge damaged***Weather Conditions**

Snow totaling 93 inches fell at the Alpentel Ski Area on Snoqualmie Pass during the period of January 21 to 25. Total water content was 9.16 inches. On the 25th, warmer weather set in and the snow turned to rain. Temperatures in the middle thirties and total rainfall of 3.10 inches on the 24th and 26th initiated a cycle of wet avalanches.

Accident Summary

A realignment of Interstate 90 over Snoqualmie Pass placed the highway along the south flank of Denny Mountain. Along this route, it was necessary to span a deep gully at a place on the mountain that overlooked Franklin Falls on the South Fork of the Snoqualmie River. A work bridge had to be constructed in this gully before the main interstate highway bridge could be built. The work bridge was fabricated from 12 x 12-inch steel "H" pilings, 18 x 43 x 1/2-inch welded steel-plate railroad "I" beams, and a wooden plank deck. The "I" beams weighed about 500 pounds per linear foot and ranged up to 70 feet in length.

During the night of January 26 or perhaps the early morning of the 27th, a wet-slab avalanche broke loose near the 3,800-foot level in the gully above the bridge. The avalanche traveled 1,000 feet vertically downslope before striking the bridge. A 300-foot section of the bridge was demolished by the force of the slide. The heavy steel beams and wood planking were carried another few hundred feet and deposited in the South Fork of the Snoqualmie River.

Avalanche Data

This was a WS-N-4 avalanche that resulted from heavy rain falling on a deep snowpack. The slide dropped some 1,100 feet vertically down the gully and left a grooved bed surface that is typical of wet avalanches. The avalanche packed enough force to uproot easily the heavy steel pilings that had been driven



No. 71-11. Franklin Falls, Snoqualmie Pass, Washington. The highway work bridge can be seen near the foot of Denny Mountain. In this photograph, only the left-hand portion of the bridge is standing; the right-hand portion was destroyed by the avalanche. The existing route I-90 can be seen in the lower right foreground.

into the ground. As great as the destructive force was, this avalanche path has the ability to release even higher on the slope and run even larger in the future.

Comments

This accident is a vivid example of the destructive forces of avalanches. Damage to

the work bridge was estimated at \$200,000 to \$250,000. In addition, a delay in the construction of the highway bridge of up to 1 year may be suffered. This highway bridge is designed to span the gully completely so that avalanches can run beneath it. The possibility remains, however, that a size 5 avalanche running down this gully may reach the piers on either side and thus damage the bridge itself.

*1 caught, partly buried, and injured***Weather Conditions**

The big storm that began on January 20 (see No. 71-8 for more details) affected the Crystal Mountain Ski Area just as it did all the Cascades. From January 20 to 27, 102 inches of snow was recorded at the ski area. High winds from the west and southwest kept the avalanche hazard so high that the upper area was kept closed for several days.

Avalanche control was carried out daily, but the results of firing the 75-mm recoilless rifle were unknown because of poor visibility. On the 25th, visibility was better, and a 4-foot slab was released by rifle fire in Silver Queen Bowl. By the 27th, the fracture line had partially filled in, slab conditions had reformed, and the cornice at the top of Silver Queen had grown to a dangerous size.

Accident Summary

On January 27, five members of the Crystal Mountain pro patrol were blasting cornices that had formed from the recent snowfalls and high winds. With them was Peter Seyler, a friend and a good skier, who was along just to watch. The group headed up the ridge on the north side of Silver Queen Bowl with the intent of blowing the cornice at the top.

The time was about 1500 when the control team reached the cornice. An avalanche guard was posted along the ridge to prevent skiers from entering the bowl. Three members of the team prepared a charge for the cornice while the team leader and Seyler skied into the bowl. They were planning to cut off some sluffs on the south side of the bowl (not directly under the cornice) and then ski out of the area before the cornice blast.

The patrolman skied along just below the south ridge of the bowl. He came to a stop in a safe area and expected Seyler to be right behind him. However, Seyler had not followed the patrolman but had kick turned and skied back under the cornice. The patrolman called out to him to come to where he was. But at that moment the cornice blast occurred!

The blast dislodged a slab below the cornice; Seyler was caught in the middle and was off on a 1200-foot ride! His ski poles were lost and his safety straps were broken during the fall. He swam with the avalanche and had the sensation of being in the surf. He came up several times for air but then was pulled under. As the avalanche slowed, he found himself near the surface and was able to thrust his head up. He was at the toe of the debris when the slide stopped and was buried to the neck.

Seyler had been carried all the way to the bottom of the bowl and had to rely on help in being dug out. The posted avalanche guard and the patrol leader skied to his aid and helped him from the snow. His ski equipment was missing, and he was suffering from a painful left leg. This was later determined to be a hairline fracture of the fibula.

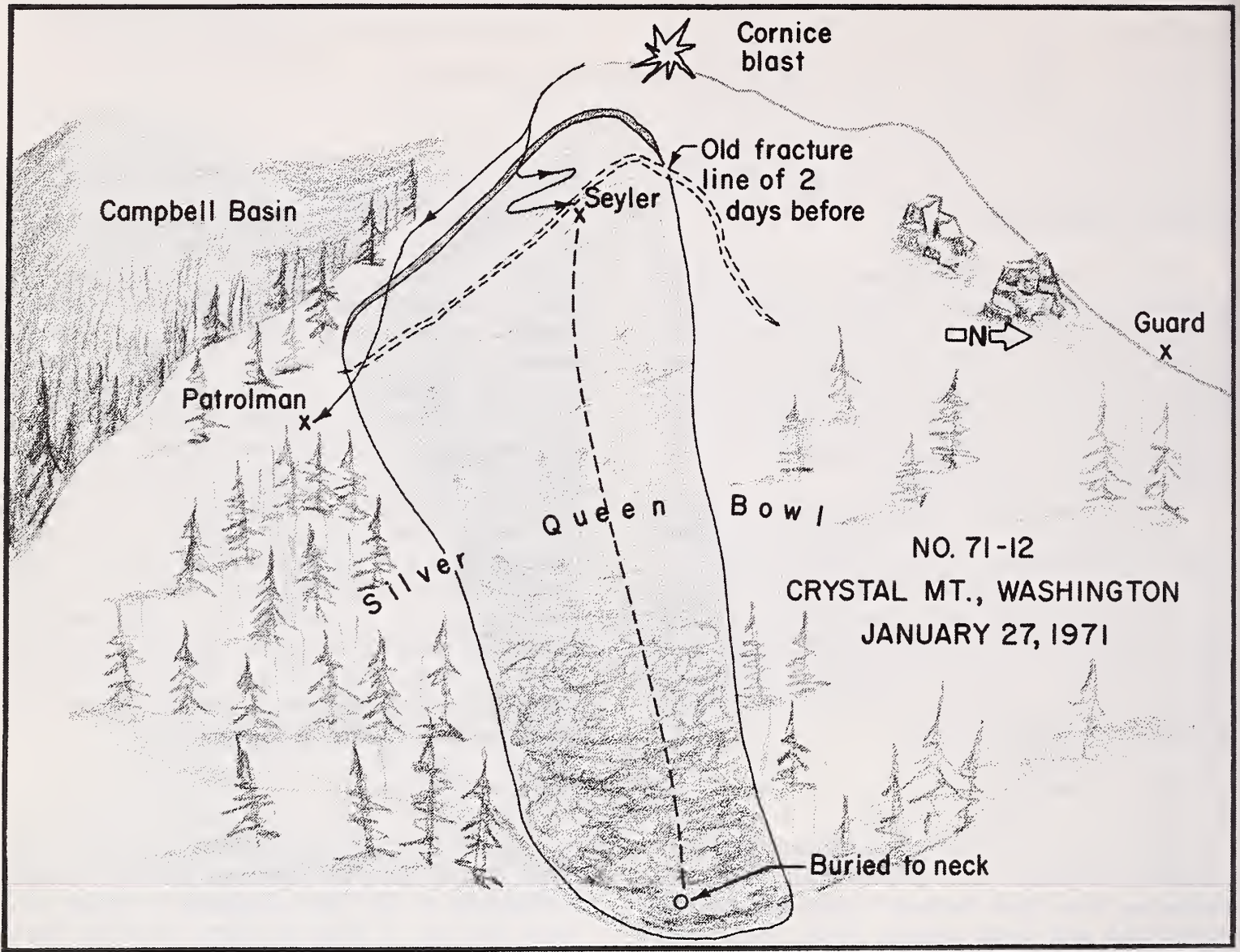
Avalanche Data

Silver Queen Bowl is an open, east-facing bowl within the ski area. It has an overall steepness of 35 ° but steepens to about 42 ° near the top. A large cornice resulting from the dominant west winds is typical along the ridge above the bowl.

This avalanche was a SS-AO-3 that resulted from the shock of the cornice blast about 100 yards away. The slide occurred on the northeast-facing portion of the bowl, fractured 3 feet deep, and dropped a vertical distance of 700 feet. A hard rain crust provided an excellent sliding surface. Debris was 10 feet deep at the foot of the bowl.

Comments

Several mistakes were made by this avalanche team, mistakes which resulted in a "close call" accident. First, it is mandatory that observers accompanying avalanche workers be kept under close supervision to prevent them skiing into dangerous areas. In this accident, this was not done. Second, there was poor communication between the blasting crew and the two skiers who entered the bowl. The cornice explosive should have never been



ignited until the blasters were certain that the area below was clear. Avalanche workers

must be well drilled and disciplined on such basics of safe blasting procedures.

*1 caught and partly buried***Weather Conditions**

Snowfall had been light for February in the Aspen area, and the avalanche hazard was generally low. A small storm moved over the area on February 26. By morning of the 27th, 4 inches of new snow had accumulated. The storm brought cold temperatures and north-west winds averaging 12 to 16 m.p.h.; the low on the 27th was -8° and the high 8° F. Avalanche hazard remained low.

Accident Summary

On the morning of February 27, a four-member avalanche control team at Snowmass went to the area's avalauncher to fire some experimental rounds into the Hanging Valley wall. Included in the group were Tom Marshall and Dick Wall. In all, 16 more 2-pound charges were fired at the wall area. These included 10 conventional rounds, all of which exploded on contact but failed to release any avalanches. Also six experimental rounds having a different type of fuse were fired. Only two of these exploded (with no avalanches), leaving four duds in the snow.

The men then skied down to the office where Marshall and Wall talked over the dud problem. It was decided to find the duds and destroy them that day. After lunch, Marshall, Wall, and patrolman Kern Krapohl went back to the Hanging Valley area. Dick Wall stationed himself at the avalauncher platform with binoculars to direct Marshall and Krapohl by radio to the dud locations.

Meanwhile, Marshall and Krapohl arrived at the top of the wall area with four 2-pound charges for blowing the duds. Krapohl went to the first dud hole, located about 50 feet below the top of the path, and marked it with a ski pole. Marshall then moved toward the next dud which was located about 20 feet below the top of the wall. He came in under the dud hole and was about to mark it with a ski pole when the whole slope started to move.

He shouted a warning to Krapohl then looked after his own preservation. As Marshall describes it, "I saw a small aspen tree

about 20 feet below me to the right. I skied for the tree and wrapped myself around it. I hung on for a couple of seconds but was pulled off the tree as it broke under the load. I went downhill over a small cliff, and the snow covered me. The snow then slid off me as it went down the hill. I continued down the hill kicking my feet and digging with my hands to keep from going farther downhill. I stopped sliding about half way down the slope. Kern was calling to me, but I couldn't talk as my chest and ribs were bruised from the tree. All my equipment—which I later found—was scattered out below me. The only thing lost was my shovel."

Marshall was carried about 150 feet vertically and fortunately did not suffer any serious injuries; Krapohl was not caught by the avalanche. Because of this accident the retrieval of duds was abandoned.

Avalanche Data

Classified as a SS-AS-3, this avalanche was about 300 feet wide and ran about 600 feet vertically. The slide paths along Hanging Valley Ridge face northeast and have a steepness of 35° to 40° near the top. Heavy timber on the west side of the ridge reduced somewhat the amount of wind-blown snow that loads these paths.

Comments

This avalanche must be included in the category of "post-control avalanches;" i.e., avalanches that run after the slopes have been controlled. In this case, two 2-pound avalauncher rounds had exploded in the area where the accident occurred. The explosion craters were located 75 to 100 feet below the line at which the slope later fractured. It was 2 to 3 hours later that the skier entered the slope, at which time it released under his skis.

One explanation of this accident is that major stability changes occurred in the 2 to 3 hours following the avalauncher rounds. Another possibility is that the exploding rounds hit a stable area of the slope, whereas

the dud and Marshall were on a much weaker area. In support of this argument is the fact that snow strengths are known to vary greatly over short distances.

Whatever the cause, avalanche workers

should be aware that explosives do not provide 100 percent effectiveness and should exercise caution whenever entering avalanche slopes. It is always a good policy to rope up when retrieving duds.

*1 caught and buried***Weather Conditions**

Jackson Hole Ski Area had received good snowfalls throughout the 1970-71 winter. On March 1, the depth of snow on the ground stood at 111 inches. A fresh storm moved into the area on the 2nd and dropped a total of 15 inches of new snow by the morning of the 5th. Although the snowfall rate was light, southwest through northwest winds exceeding 20 m.p.h. had formed moderate slab conditions. Temperatures remained cold, reaching a high of only 14°F on the 5th.

Accident Summary

On the afternoon of March 5, a party of three skiers asked permission to ski a permanently closed section in Cheyenne Bowl. The party included Jeff Roberts, Steve Rieley, and Jim Stanton. Permission was granted by the ski patrol leader without consulting the snow ranger. The party skied down Rendezvous Bowl to the Cheyenne Traverse. They then skied under a cable and signs stating "Cliff Area Closed" and started their downhill run in the powder; Stanton was on the west side, Rieley in the middle, and Roberts on the east. Roberts had made one turn under the cliff area when the slope fractured 15 feet above him. He was swept down the steep pitch and when the slide came to a halt was nowhere to be seen. His two companions searched in vain for a few minutes before Stanton went for help.

Rescue

A hasty rescue party of 10 men arrived at the scene at 1605, 15 minutes after the slide had run. The last-seen point was obtained

from the two eyewitnesses, and a coarse probe line was established at the toe of the avalanche beneath this point. After 20 minutes of probing, and before the Stage II rescue party had arrived, the victim was found.

Located under 4 feet of snow, Roberts was conscious but suffering from shock. He had been buried for 36 minutes. He was taken by toboggan to the bottom of the mountain and then taken to the hospital for observation.

Avalanche Data

This avalanche was a SS-AS-2, having a 2-foot-deep fracture line that was 100 feet in length. The avalanche fell 300 feet vertically down the 37° slope. This open, south-facing slope is permanently closed and never skied, but it is hand charged because of the threat to the ski trail at its foot. The bed surface of this slide was a very definite hard, icy crust.

Comments

It is not known why permission was granted to this party to ski a permanently closed area, an area that had received no ski stabilization all winter. Had the ski patrol leader checked with the snow ranger, permission to violate the closure would have been denied and the accident avoided.

The rescue was a textbook case in speed and efficiency. The patrol was well-equipped and was on the scene in minutes. The last-seen point was marked, and coarse probing began below this point near the toe of the debris. All these procedures measured up to giving the victim the best possible chance of survival. In this case, the expertise of the rescuers was invaluable: it saved the victim's life.

*1 caught and partly buried***Weather Conditions**

Eleven inches of new snow was recorded at Aspen Mountain Ski Area on the morning of March 5, and two additional inches fell overnight on the 6th. Northwest winds averaging 15 to 20 m.p.h. had produced some shallow slab conditions. On the 6th at noon, the temperature was near 15°F after an overnight low of -4°F.

Accident Summary

Near noon on March 6, Mike Pokress and two companions skied outside the Aspen Mountain area boundary and onto a slope called Cristy Gully. They skied part way down the gully and stopped on Loushin's Road. Pokress was in the middle of the gully and his two companions were on the side when another skier entered the top of the path. The snow suddenly fractured beneath this skier and released a soft-slab avalanche. Pokress was directly in line with the slide and had no chance to escape. He was swept off the road and down the gully to the flats below—a ride of 300 feet.

Rescue

A separate party of three Aspen Mountain patrolmen coincidentally was standing at the top of the gully and witnessed the slide. Two of the patrolmen went down the slide path to offer immediate help while the third skied out to the patrol phone on North Star to request a rescue party.

When the two patrolmen arrived at the avalanche debris, they found Pokress completely buried except for his head and part of one arm. He was dug out unharmed. His two companions and the skier who released the slide all escaped the avalanche. Pokress skied out under his own power, and the hasty rescue party, which had arrived in the meantime, was disbanded.

Avalanche Data

Classified as a SS-AS-3, this slide had a 1½-foot fracture line and dropped a vertical distance of 600 feet. The sliding surface was a sun crust on which the new snow had fallen.

Cristy Gully is an open, east-facing slope just outside the eastern boundary of the ski area. It is a known avalanche path that is not often open to skiers, and most of the powder hounds who do ski it, ski around the steepest part and enter at a lower point on the slope. All things considered, Cristy Gully is a dangerous avalanche path that will always have its share of accidents. (In December 1972, a lone skier violated a closure to ski this path: she paid with her life.)

Comments

Skiers who enjoy skiing avalanche paths should never expose themselves to more risk than is necessary. Skiing the steep and untracked is fun, but if they survive their downhill run, they should admire their tracks from a safe vantage point, not the center of the path.

*1 caught, partly buried, and injured***Weather Conditions**

On March 11, a storm moved over the Sun Valley area and began depositing snow lightly at first but with increasing intensity as time passed. Measured snow amounts on top of Bald Mountain were 1 inch (with 0.11 inch of water) on the morning of the 11th; 5 inches (and 0.45 inch) on the 12th; and 9.5 inches (and 0.90 inch) on the 13th. Winds during the storm blew from the southwest at average speeds ranging up to 38 m.p.h. Following the storm, the winds shifted to the west.

The old snow surface onto which the new snow fell was an ice crust that had originally formed during a period of rain in mid-January. This crust had since been modified by the sun but remained as a potential avalanche sliding surface.

Accident Summary

Snow Ranger Gary Harper describes the day's activities and the ensuing accident, which occurred in an area known as 75-mm Bowl in the following narrative: "On the morning of the 13th, control work was started in the 'bowl area' of the Bald Mountain Ski Area. Supervision of the work was by myself and District Ranger John C. Combs with 14 members of the Sun Valley Ski Patrol doing the hand charging and protective skiing. We left the patrol shack at 0915 and proceeded to do the cornice control work along the top of the bowls: at each bowl we dropped off four-man hand-charge and protective-ski teams.

"When we reached Mayday Bowl, I decided to cut back across the area to see how the work was going in Lookout and Easter Bowl. Patrolman Dick Forster and I traversed across these areas and saw that the control teams had finished their work and were heading down. Therefore, we decided that by traversing on across we could control the small bowl located directly under the 75-mm gun.

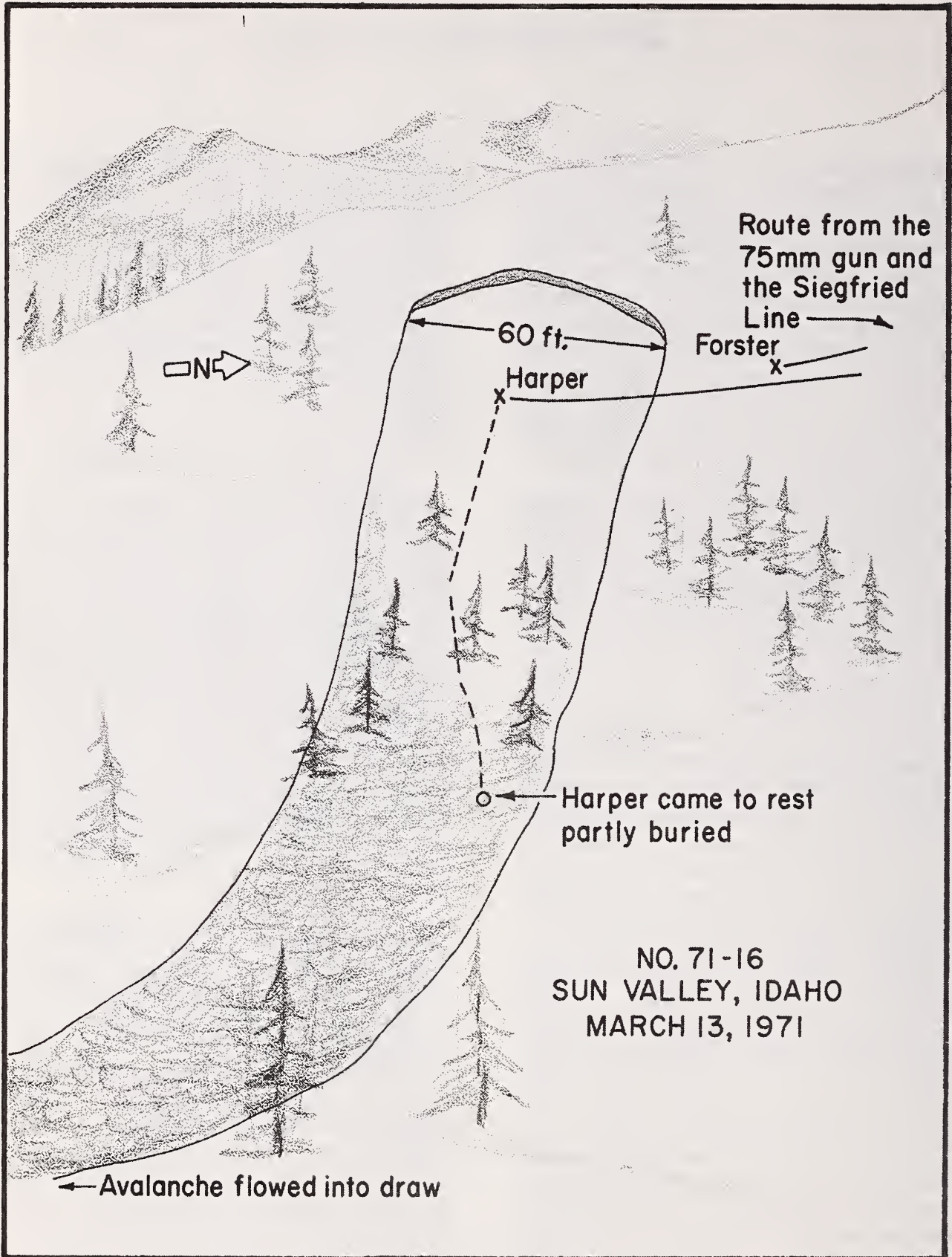
"We came out on the ridge 100 yards above what is called the Siegfried Line. The

actual area we wanted to work was about 50 yards below this road. I made two or three turns and planned to cross back to the ridge just below the road and throw hand charges from that point. I got my skis hung up in some heavy snow and was unable to make the turn back to the ridge. I called to Forster and told him to stay high, but he didn't hear me and followed my tracks on down. I told him that I thought we should be crossing 30 feet up the hill, and he said he would stay put while I went across to the ridge, some 70 feet distant.

"I had gone about 20 feet from the trees when I saw the snow fracturing around me. I looked up the hill and could see the fracture line some 20 to 30 feet above me. At this time I tried to ski forward and out of the slide but could see that I wouldn't make it, so I turned downhill to try and ski back out in the direction I had come. By this time the slab was well broken up and I was knocked off my feet. From this point on I could not tell how large the slide was. Because it was moving fairly fast, my main thought was to get stopped. I passed several trees but could not get hold of them. Finally I was able to get one ski against a large Douglas fir on the uphill side, and I think this slowed me down some; I stopped about 70 feet below the tree.

"During the slide I called to Forster to keep his eye on me. I also began to swim and found it quite easy to stay on top of the snow. My head was covered only one time for a few seconds and when I stopped I was only in snow to mid-thigh.

"At some time during the slide (probably when I came in contact with the tree), I ruptured the Achilles' tendon of my right leg. I had lost my left ski, both poles, and glasses during the slide, and the binding on the right ski had released. At this time I called up to Forster and told him that I was okay, other than my leg, and that he should go back to the ridge and ski down Easter Bowl and let the patrol know what had happened. I then used my one ski and went on down the draw to the bottom where I met Forster and the head of the patrol. We called for the helicopter and it took me on to the hospital."



Avalanche Data

This avalanche, classified as a SS-AS-3, had a 2-foot fracture line and dropped some 500 feet vertically down 75-mm Bowl. The avalanche consisted of only the new snow sliding on an old, icy crust. The small bowl has an east exposure and a steepness of 37° in the upper area. Douglas fir trees are scattered throughout the area.

Comments

Gary Harper had skied for 25 years and has been snow ranger at Bald Mountain since 1965; he knows the mountain as well as anyone. He offers the following observations on his accident: "All signs pointed to the fact that we might get some slide activity, and my first impulse when I found myself too low on the

slope was to climb up and around. However, past experience told me that the slide should break under the rocks near the ridge. I failed to take into consideration the overall ice layer, and the very poor bonding of new snow to it. Also, there was a natural shear point or tension zone where it would be natural for a fracture to occur. We also had two hand charges which we planned to use and could have used safely before attempting to cross the slope.

"It was quite easy to stay on top of the snow (by swimming); all things I had been told to do were going through my mind, and I tried them all. The most important thing that comes to mind is that I did not pay attention to the first impulse I had, which had apparently been a correct one. This was the feeling that said: 'There is something wrong but I'm not sure just what it is!' We certainly should have used those hand charges."

*1 caught, buried, and killed***Weather Conditions**

On the evening of March 13, snow began falling in the Aspen area signalling the approach of another storm. By the next morning, 13 inches of snow containing 1 inch of water had fallen. West-to-northwest winds averaging 12 to 18 m.p.h. had contributed to slab formation in the area. An additional 1 inch of snow fell during the day of the 14th.

Moderate snow fell on the 15th until 6 more inches of new snow covered the ground on the morning of March 16. Northwest winds persisted on the 15th and 16th, and temperatures were mild with highs in the upper twenties.

Accident Summary

On March 16, Deep Powder Tours, Inc., which operates snow cat tours in the backcountry, had a party of eight skiers ready to hit the new snow. In addition to the skiers were co-owner Tom Cleary, ski guide Tom Simpson, and snow cat driver Glen Sharp. They were to ski the slopes off both sides of Richmond Hill, south of Aspen Mountain Ski Area.

By afternoon, the party had made five downhill runs and was headed for the slope between Independence Bowl and Black Diamond Bowl on the east side of Richmond Hill. While en route, they noticed four sets of fresh ski tracks entering the north draw of Independence Bowl. After unloading at the top of their ski slope, it was agreed that guide Simpson would ski over to the south draw of the bowl to see if these unidentified skiers had safely departed. Independence Bowl, also known as McFarlane Gulch, is recognized as a high-hazard avalanche path and is almost never skied: thus, Simpson was concerned that the four skiers might have been caught in an avalanche.

While Simpson went to check out the ski tracks, the rest of the group was to ski on down; the ski party, the snow cat, and Simpson were all to meet at the bottom. The time was about 1500 when Simpson skied off from the group.

The ski party met the snow cat a short time later, but Simpson did not appear. Thinking he had been delayed, they rode the snow cat back up and took another ski run down the slope. When Simpson had still not shown, they rode the cat up to the top of the south draw of Independence Bowl to look into the area. What they saw was shocking; almost the entire bowl had avalanched with Simpson's tracks leading into the fracture line. There was no sign of Simpson!

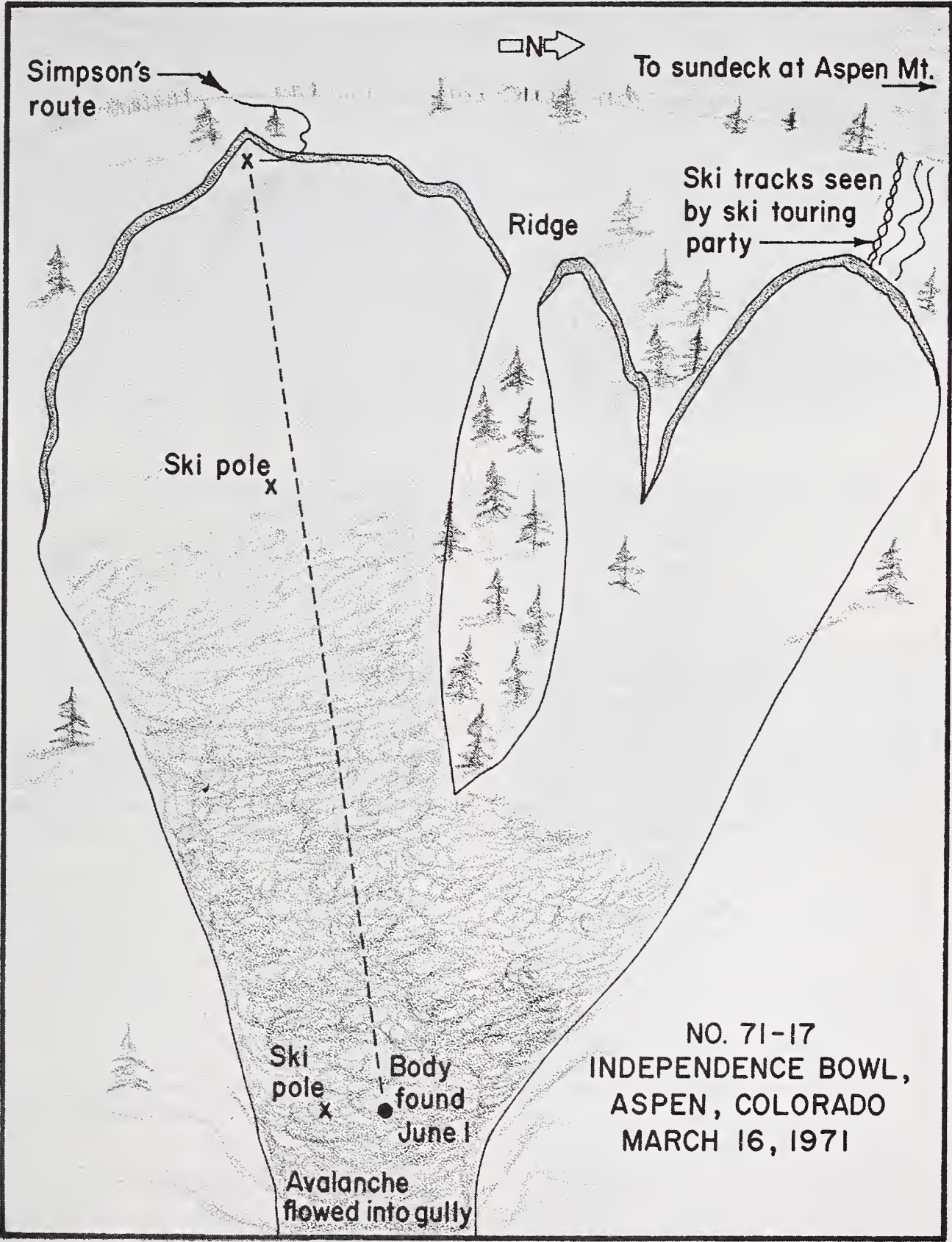
Rescue

At this point, the snow cat was sent to the Sundeck at Aspen Mountain to summon help while Cleary led the rest of the ski party on a hasty search. Already 1 hour had elapsed since Simpson had left the group; and after the hasty search group failed to find any sign of him, his chance of survival was dimmed even further.

The Aspen Ski Patrol, the U.S. Forest Service, and Mountain Rescue - Aspen were all notified of the accident by Glen Sharp, the snow cat driver. Eight Aspen patrolmen were on the scene at 1635, about 1½ hours after the accident occurred. Soon, one ski pole was found a short distance below Simpson's entry point, and some time later the second pole was found another 500 yards down the path. By lining up the two poles and the entry point, the searchers had a good estimate of the victim's line of descent. The search was concentrated along this band of the massive avalanche.

By 1820, 42 persons were involved in the search; an hour later there were 70. A helicopter was in use ferrying Mountain Rescue personnel to the scene. Head lamps and food rations were distributed by the Forest Service as rescue efforts extended into the night. Two coarse probe lines had been established, but the hardness and depth (20 feet or more in places) of the debris slowed progress.

At 2000, the search leaders agreed to end the search for the night, and by 2030, about 5½ hours after the avalanche occurred, all the rescuers were out of the bowl. Eighty-five





No. 71-17. Independence Bowl, Aspen, Colorado. Looking up the bowl. The victim was caught in the draw on the left. Portions of the fracture line can be seen across the top of the bowl.

searchers were present at that time. A meeting was held later that night to plan the following day's operations. It was recognized that there was essentially no chance of finding the victim alive: the rescue efforts were now aimed at recovering the body. Avalanche control in the bowl was planned for in the morning before the rescuers were sent into the bowl. Also, plans were made to provide food and equipment for up to 100 searchers.

At 0900 on March 17, blasting began in the area, and at 1000 snow cats began to ferry in the searchers who had assembled at the Sundeck at Aspen Mountain. A total of 124 searchers systematically coarse-probed the area with completely negative results. Badly deteriorating weather forced a withdrawal of the rescue group in mid-afternoon. On the following day, March 18, a similar rescue group effort was staged, again with negative results.

During the next 2 days, March 19 and 20, a different approach was taken. Two search-and-rescue dogs from the Sheriff's Office of Great Falls, Montana were taken to the accident site. The dogs worked well and uncovered numerous cigarette butts, sandwich bags, and other items discarded by the searchers, but they failed to find the buried victim. The effectiveness of the dogs was clearly

hampered by the hundreds of rescuers who had trampled the area before the dogs had a chance to work it.

After 5 days of searching with probe lines and avalanche dogs had proved futile, the rescue effort was called off. It was agreed, though, that Mountain Rescue - Aspen would periodically check the bowl as snow conditions changed in the spring.

On June 1, eight men from Mountain Rescue - Aspen went to the bowl by snow cat. Upon entering the bowl, the body of Tom Simpson was immediately sighted in the lower center part of the bowl. He had been carried about $\frac{1}{2}$ mile slope distance and had fallen some 1500 feet vertically. The body was located 100 feet to the side of where the lower ski pole had been found. Coarse probe lines had passed directly over this area, but the victim had been buried so deeply—perhaps as much as 18 feet—that the probe poles hadn't come close to striking him. (The great depth of the burial also explains the lack of success by the avalanche dogs.) The victim had sustained a severe head injury during the avalanche that may have resulted in sudden death.

The body of Tom Simpson was evacuated on the afternoon of June 1, thus ending the rescue that had begun 11 weeks earlier.

Avalanche Data

Independence Bowl is a tributary of McFarlane Creek on the east slope of Richmond Hill, lying about 1 mile southeast of the Sundeck at the summit of Aspen Mountain Ski Area. It lies about 1 mile south of Cristy Gully, the sight of two avalanche accidents (No. 71-15 and a subsequent accident in December 1972). The bowl has two distinct draws separated by a ridge in its upper half. These draws then converge toward the bottom of the bowl as it pitches into a narrow gully—McFarlane Gulch. The bowl covers an areal extent of approximately 70 acres, most of it only lightly dotted with trees. It has a steepness of about 33° in the starting zone.

Independence Bowl has a long avalanche history and has produced some large slides in the past. In the spring of 1965, for example, an immense slide released in the bowl, running about 2 miles in length and dropping some 3000 feet in elevation. This avalanche almost reached State Highway 82 at the valley floor.

The avalanche in this accident was a HS-AS-4, starting at the 11,000-foot elevation and running to 9300 feet for a vertical drop of 1700 feet. The slide ran a slope distance of almost 1 mile. It was 1600 feet wide at the top and narrowed to 150 feet at the toe where the debris reached depths of 20 feet.

This slide was triggered as the victim skied into the south draw of Independence Bowl; apparently the avalanche released slightly above him. Most probably then, the south draw slid out first and undercut the

snow in the north draw, which then released. The accumulated snow from both halves of the bowl buried the victim to a hopeless depth. The fracture line averaged 4 feet deep, with the slab going to the ground in places, however, it slid mostly on a hard icy layer which had remained in the pack since January when the bowl had avalanched naturally. Twenty-nine inches of depth hoar lay at the bottom of the pack.

Comments

Tom Simpson, a highly competent skier, was considered to be very safety conscious and was well acquainted with the terrain and its hazards. On the day of the accident, it was his concern about the safety of another group of skiers that led him into the dangerous area where he tragically became the victim himself. This concern for another's safety led to several errors that on any other day he would not have committed. First, he entered a known avalanche area, taking a route that proved to be anything but safe. Second, he skied into the area alone. Third, he had taken no avalanche safety precautions such as carrying an avalanche cord or a Skadi.

An electronic avalanche rescue beacon such as a Skadi is highly recommended for all ski touring guides (and for members of their parties). It cannot be too strongly emphasized that the only chance a buried ski tourist has at life is to be found by his companions. A Skadi offers the best possible hope in backcountry avalanche burials.

3 caught; 1 partly buried and 2 buried; 2 killed

Accident Summary

The Eklutna Glacier lies approximately 25 air miles east of Anchorage, Alaska in the Chugach Mountains. On Saturday, April 10, two men and a woman set out on an extended climbing - ski-touring excursion. They were well equipped and carried both skis and crampons. Their plans were to traverse the Eklutna Glacier snowfields and to arrive after about a week at the community of Girdwood. The three were John Samuelson, Hans Van Derlaans, and Dr. Grace Hoeman, all experienced mountaineers.

The three climbers were driven by snow-machine to the foot of the glacier where they began their trek. Using crampons, they ascended a steep, southwest-facing slope to a cabin located at the 5000-foot level on a rock outcrop above the glacier, and there they spent the night. The weather deteriorated badly overnight so that on Sunday, April 11, they were forced to spend the day in the cabin. The weather did not improve the following day as snow continued to fall, accompanied by strong winds. Because of the weather, the group decided to cancel the rest of their tour and return to Anchorage.

At about 1330 on the 12th, the three climbers began descending the steep snowslope between the cabin and the glacier. This was the same slope they had climbed two days earlier; at that time the snow surface had been hard, following several clear, sunny days and cold nights. Two days later, however, 2 feet of new snow covered the slope, prompting the three climbers to stop before entering and discuss the safest route. In spite of poor visibility, they had seen several fresh avalanches on adjacent slopes and were suspicious about the one they had to cross. It was agreed to cross high, one at a time, and reach the relative safety of a ridge on the far side.

As Van Derlaans and Dr. Hoeman waited, Samuelson entered the slope alone and on foot, breaking trail on a high traverse. All three were wearing crampons and had their skis strapped to their packs. After several minutes Dr. Hoeman inexplicably entered the slope

much lower on a steeper traverse. Van Derlaans followed.

Samuelson noticed his companions lower on the slope and came to a stop. Just as he was about to shout them back off the slope, the snow fractured all about him. He was carried helplessly downhill on a fast ride but fortunately came to rest buried only to the hips. Hoeman and Van Derlaans were totally overwhelmed by the avalanche. Both were carried out onto the glacier and were buried under tons of snow!

Samuelson managed to dig himself out and immediately began searching for his companions. He probed the debris for 2 hours with his ski pole but found nothing. With little hope of success, Samuelson began his descent, arriving at the south end of Eklutna Lake at 2030 where, because of exhaustion, he set up camp. The following morning, April 13, he reached the highway and hitched a ride to Mirror Lake where he contacted the Alaska State Troopers.

Rescue

The State Troopers immediately called the military rescue group at Elmendorf AFB in Anchorage. At 1310, Samuelson and a state trooper were picked up by a rescue helicopter and flown to the toe of the Eklutna Glacier. However, poor visibility prevented the rescuers from viewing the avalanche area. They then returned to Ft. Richardson, Anchorage, and met with the Army Mountain Rescue Team. At 1500, six members of the Army Mountain Rescue Team plus four members of the civilian Alaska Rescue Group were airlifted to the south end of Eklutna Lake where a base camp was established.

On the morning of April 14, the 10 rescuers were flown to within a short distance of the accident site. Upon reaching the avalanche area, they discovered that the recent snows had obscured all traces of the avalanche. A probe line was established, but a lengthy search revealed no sign of the buried victims. Rather than return to base camp, the rescuers dug snow caves and stayed overnight

at the accident site.

Probing the following day again revealed no clues. Because of poor weather and the danger of more avalanches, the rescuers left the area at noon and were airlifted back to Anchorage. In a meeting at Ft. Richardson, it was decided that the Army would provide transportation and communications for a team of 20 volunteers from the Alaska Rescue Group to continue the search.

On April 16, the rescuers were airlifted to the accident site and a camp was established. The avalanche area was methodically probed for 2 days with negative results. Finally, on the 18th, the search was cancelled, and all rescuers were flown out of the area.

The search came to a final conclusion in early summer when the melting snow revealed the bodies of the two avalanche victims. Dr. Hoeman was found face down, head downhill, in a stretched out position with ice axe in hand. Her pack was a short distance away. Van Derlaans was found in a vertical position, head down and feet up. His heavy pack with skis still on his back; this evidently was the reason for his being found in such a

helpless position.

The discovery of the bodies also revealed to the rescuers that their earlier searching and probing had been badly misdirected. Because new snow had concealed the avalanche debris, the rescuers had mistakenly probed only the very edge of the avalanche; this explained their unsuccessful recovery attempts.

Comments

The three mountaineers involved in this accident were highly experienced, a fact that makes the actions of two of them all the more puzzling. Dr. Hoeman and Van Derlaans voided the safety plans agreed upon by moving onto the slope beneath Samuelson. Instead of crossing high and one at a time, all three climbers were suddenly on the slope at the same time. This mistake proved to be fatal for Dr. Hoeman and Van Derlaans.

As a final footnote to this tragedy, it is interesting to observe that Dr. Hoeman was no stranger at all to avalanches. Indeed, her husband had died an avalanche victim himself only a few years before.

2 caught and buried; 1 killed

Weather Conditions

The Colorado Rockies were hit with two September snowstorms that left an early snow cover in the higher elevations. On the afternoon of October 15, a sizable storm moved over the San Juan Mountains. Snowfalls of 2 feet or more over the following 2 days covered the mountain peaks; Silverton received 1.17 inches of precipitation. Isolated pockets and gullies on the mountainsides accumulated snow depths of 3 to 6 feet.

Accident Summary

The Colorado elk season had begun, and hunters were swarming over the mountains on the weekend of October 16 and 17. Two hunters from Amarillo, Texas—Marion S. Martin, 48, and James Logsdon, 32—were hunting on the slopes of Pole Creek Mountain in the San Juans on October 17. It was shortly after 1600 when the two men attempted to cross a snow-filled gully on the northwest flank of Pole Creek Mt. Both men entered the gully with Martin in the lead and Logsdon behind and about 10 feet lower. Logsdon looked up in time to see the snow break above them and shouted a quick warning to his friend: "Look out, M. S., run! Here comes the snow!" Martin turned, took two steps, and was bowled over by the avalanche. He was tumbled head over heels downhill and carried out of sight.

Logsdon was also hit hard by the snow and swept downhill. But after a short ride, his rifle caught in a bush and held fast. The snow swept over him, burying him completely but shallowly. He was able to dig himself out after several minutes and began searching for Martin. He searched the snow for 45 minutes but found no sign of his companion. He also fired his rifle into the air to summon the aid of any other nearby hunters, but his call went unanswered. Logsdon finally left the area and returned to his base camp near the confluence of Pole Creek and Bear Creek at 1915 where the accident was reported to fellow hunters.

Rescue

While one man drove out to summon aid from outside, a group of six hunters returned to the avalanche site. In the darkness their search uncovered no signs of the missing man.

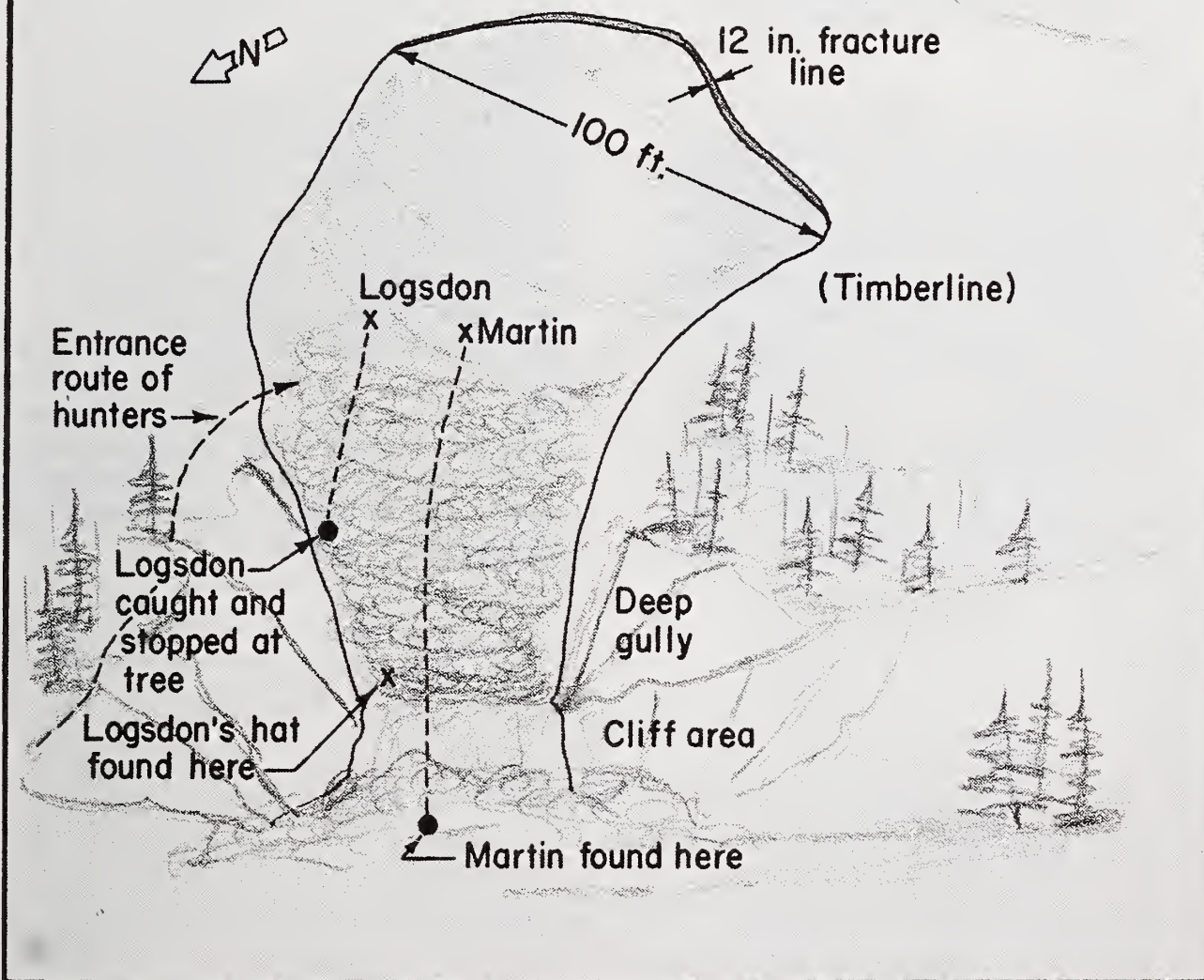
Because of the extreme remoteness of the area, an organized rescue unit traveling in 4-wheel drive vehicles did not arrive until the afternoon of October 18, the day after the accident. The hunting camp was located 12 air miles east of Silverton and 30 air miles west of Creede and except for the possible use of a helicopter, all travel to and from the camp was over 4-wheel drive roads. At this time of year, however, almost 2 feet of new snow covered the roads with drifts up to 5 feet deep, making overland travel an adventure in itself.

The rescuers included: Don Alford of the University of Colorado Avalanche Research Project in Silverton; San Juan County Sheriff Virgil Mason and a crew of four from Silverton; Glen Hinshaw of Creede; and four members of the Adams State College Rescue Unit from Alamosa led by Greg Simmons. The ASC group was the first to arrive at the avalanche site, reaching their destination at 0930 on the 19th after a 2-mile, 4-hour uphill trek from base camp. With them was the shaken and exhausted survivor, James Logsdon. Four hours of scuffing and probing with ski poles revealed nothing.

At 1300, the remainder of the rescuers arrived equipped with 12-foot probe poles and a metal detector. A 10-man coarse-probe line was set up and covered the entire debris area in the upper half of the track. Only a hat belonging to Logsdon was found. At 1600, the search was called off because of approaching darkness and because of the threat of more avalanches in the gully. All rescuers left the site for the long walk back to base camp. Because there was almost no hope now of a live rescue, the search was temporarily halted until the slopes could be stabilized with explosives and a larger rescue unit could be airlifted in. The debris in the lower half of the track had yet to be thoroughly searched.

On October 23, 6 days after the avalanche,

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Alford, Sheriff Mason, and three other rescuers were helicoptered back to the avalanche site. Their job was to hand-charge any slopes that would endanger rescuers working below. A 16-man probe team would be flown in from Silverton when the explosive work was completed.

Several charges were thrown but no slides released. While awaiting the arrival of the probe team, Alford and another man walked to the base of a 20-foot cliff over which the avalanche had run. The area below the cliff had not been searched during the initial rescue effort. While scuffing this area, Alford uncovered the missing man's foot from under 6 inches of snow. Marion Martin's body was uncovered, head downhill and under 18 to 24 inches of snow. He had died instantly from a broken neck suffered in either the downhill tumble or the fall over the cliff. His right leg had also been broken in the fall. The search and rescue came to an end with the airlifting of Martin's body back to Silverton.

Avalanche Data

This avalanche was classified as SS-AO-2, being released by the two hunters walking across the starting zone. The fracture line averaged 12 inches in depth and was about 100 feet in length. The avalanche ran approximately 300 feet slope distance down the gully, digging to the ground in places. The avalanche released at approximately the 11,700-foot level on the northwest flank of Pole Creek Mt., slightly above timber line. The starting zone was the north-facing side of a deeply incised gully and was quite steep—about 50°. The avalanche was channeled to a width of no more

than 50 feet in the narrow gully.

A hasty snowpit dug in the starting zone revealed 22 inches of new snow lying atop 4 inches of depth hoar. This avalanche is a classic example of an early season soft slab failing in a shallow snowpack. The depth hoar began developing in the very shallow snow cover that remained on the high-elevation, north-facing slopes after the September snowstorms. The snow and strong winds of the October storm formed a highly unstable soft slab needing only a slight trigger for release. During the period of October 19 to 23, a cycle of small natural soft-slab avalanches occurred in the San Juans as a result of this instability.

Comments

This accident focuses clearly on the dangers of a shallow snowpack - depth-hoar combination. The point is clear: *shallow pockets of snow at high elevations, and especially on north-facing slopes, are to be avoided in early winter.* The snow cover from the first storm or storms of the winter, if followed by clear, cold weather, is the breeding ground of depth hoar. It is inevitable, then, that widespread instability results when the next large snowstorm dumps its heavy load directly on top of this weak substratum. Avalanche hazard is at a maximum under these conditions.

In reviewing the rescue effort, it bears pointing out that the rescuers should have spent more of their initial effort in scuffing the *entire* debris area rather than concentrating on the upper half. Had the lower track—the area below the cliff—been scuffed, the victim's body may well have been found on the first day of the rescue.

2 caught; 1 partly buried and 1 buried

Weather Conditions

Snow began falling at Vail on November 26 as a small storm moved through the Rockies. By the morning of the 28th, a total of 14 inches of snow had accumulated. Moderate winds on the 27th had produced spotty slab conditions within the ski area.

Accident Summary

At 1115 on November 28, a group of five skiers entered Northwoods run and hugged the west edge of the run to ski the unpacked snow. The group stopped briefly on a small knoll, and then Peter King skied down the face of the knoll, fell, and lost a ski. Jackie Flater skied down to help Peter, and as she did so, the snow fractured above them. Both were carried down the short face of the knoll about 30 feet. Peter came to rest with only his head out of the snow; all that was seen of Jackie was a single ski tip. The two being side by side, Peter reached out and swept away the snow cover-

ing Jackie's face; although covered by snow, neither of them had been injured. The other three skiers helped both victims out of the snow. Peter had lost a ski; a Vail ski patrolman retrieved it later in the day.

Avalanche Data

This slide was classified as a SS-AS-1, fracturing 2 feet deep but running only 45 feet vertically. Even so, enough snow moved down this short north-facing slope to almost completely bury two skiers.

Comments

This accident is an example of the hazard to skiers from even very small avalanches. Although carried only 30 feet, Ms. Flater was completely and helplessly buried. Without the help of friends, she may not have survived this avalanche. Contrast this accident with No. 67-10 in which a patrolman skiing alone on sweep did not survive a small avalanche.

*3 caught***Accident Summary**

Monday, December 13, was "opening day" for the upper half of the mountain at Jackson Hole. Because all skiers riding the tram to the top must ski Rendezvous Bowl, it was mandatory that avalanche conditions be thoroughly checked out before opening the bowl. Thus, 4 days earlier on December 9, the bowl was heavily shot but with no avalanche release. On the morning of the 13th, the bowl again was heavily shot. A total of 60 pounds of HDP was used, mostly in 4-pound buried charges. Once again, no avalanches were released. At noon on the 13th, Rendezvous Bowl was opened to skiers.

The sky had been overcast all morning, but at about 1300 the clouds dissipated and the sun shone brightly on Rendezvous Bowl for the first time in many days. Two tram loads of skiers (about 100 skiers) had already skied the bowl by 1325, and the third tram load was in the bowl at this time. At 1330, after the majority of the third tram had already skied the bowl and were out of the area, the entire north half of Rendezvous Bowl fractured to a depth of 2 to 3 feet and avalanched. A number of skiers were still in the bowl and watched as the avalanche ran to the bottom of the bowl and stopped in scattered timber.

The ski patrol was immediately notified of the avalanche, and several patrolmen were at the scene within minutes. Nine eyewitnesses were quickly questioned; their statements ranged from no one caught to as many as three skiers caught. Search and probing began immediately and continued throughout the day. At the same time a check of skiers was begun to see if anyone was reported missing. By 1730, the probe had revealed nothing, and all persons who had been reported missing at various times during the afternoon were found and accounted for. The rescue was terminated at this time with strong evidence that no one had been buried. This eventually proved to be true.

Avalanche Data

This avalanche was a HS-N-4 that incredi-

bly released when a minimum number of skiers were in the vicinity. The fracture line was 2 to 3 feet deep and was about 400 feet in length, extending from the center of Rendezvous Bowl to within 50 feet of the tree line on the north side of the bowl. Three shot holes were cut in half by the fracture line. The avalanche fell some 600 feet vertically. The run-out zone was covered by debris 2 to 12 feet deep with an average depth of 3 to 4 feet. Rendezvous Bowl faces east and has an elevation of 10,300 feet at the avalanche release zone.

The avalanche ran on an old, icy sun-crust layer approximately 18 inches above the ground. Beneath this crust was a layer of depth hoar just above the ground. The avalanche broke through the crust in places, digging to the ground and exposing many rocks and boulders.

Comments

This near-accident falls into the category of post-control avalanche releases. If anything, the explosive control in Rendezvous Bowl prior to the avalanche was an example of overkill. Sixty pounds of explosives were spaced around the top of the bowl on the day of the avalanche, and a similar amount was used 4 days earlier. It is difficult to imagine how the avalanche failed to respond to such a wallop. So the difficult question arises: What really caused this avalanche? Unfortunately, we cannot definitely answer this question; we can, however, discuss three interesting and controversial possibilities that may have contributed to failure.

It is clear that the stability of the slope decreased after it was shot in the morning. So we must first ask, did the explosives contribute to the instability by either weakening the internal strength of the slab or jarring it loose from its ground anchor? There is no evidence to suggest that this happened, yet the possibility cannot be categorically dismissed.

Secondly, we need to ask: Was this a case of "temperature release"? That is, did solar radiation decrease stability to the point of failure? The sun had been shining on the slope

for about one-half hour preceding release. Whether the sudden application of solar radiation to a cold snowpack or the removal of sunshine can cause avalanche release is currently a matter of debate, and needs further study (see No. 67-10 also.)

A third possibility is that the collective effect of more than 100 skiers eventually decreased the stability of the slab to the point of failure. This was the first day of skiing for the season in the bowl, and a large number of persons skiing over a completely uncompact area is likely to either increase stress or cause a redistribution of stress within the slab; either, or both, could have

caused failure.

The key word in the preceding statement is "uncompacted". This case exemplifies a classic hard-slab condition, a stiff layer of snow lying atop a hard crust and a layer of depth hoar. Without compaction, the depth hoar provides an intrinsic weakness to the snowpack, a weakness that is not corrected by the use of explosives. The only solution is artificial compaction to destroy the depth hoar and retard its reformation. Bootpacking and continuous skiing are the best methods of compaction and offer a distinct measure of safety against these mostly unexplained post-control releases.

*1 caught and buried***Weather Conditions**

Snow began falling over the Wasatch Range on December 23 and by the morning of December 27, 33 inches of snow had fallen on the steep slopes of Snowbird. Avalanche control had been carried out routinely during the storm without much activity.

Monday, December 27, was clear with light winds and temperatures in the midtwenties. Avalanche control on this day brought lots of sluffing and a few small avalanches. An unnamed chute in Peruvian Gulch (later named Nye's Chute) was hit in mid-track with a 2-pound charge at about 0830; no avalanche resulted. After all control teams had run their routes, the mountain was opened to the public. No closures were in effect as the result of the control work indicated that the overall avalanche hazard was low.

Accident Summary

Bret Nye, 19, had been skiing in the Snowbird area all morning and shortly before noon left the tram and skied along the ridge toward Baldy. He and three companions entered the steep chute now named Nye's Chute at the top of Peruvian Gulch. The time was 1200. A loud crunching noise was heard as the snow fractured 100 feet upslope of Nye's track. This was a deep avalanche that quickly overwhelmed the skier. His progress in the avalanche was observed for about the first 100 feet of his descent by his companions, but then he disappeared in the churning mass of snow. When the avalanche stopped, there was no sign of Nye. The chute had fractured about 200 feet upslope of the shot left by the morning's control work.

Rescue

The Snowbird ski patrol received word of the slide at 1215. At 1225, a hasty-search group of three patrolmen arrived at the avalanche site and began organizing approximately 20 skiers who had stopped to help. Five minutes

later the main rescue party arrived and several coarse probe lines were established. Approximately 50 rescuers were at the scene at this time.

At 1330, after being buried for 75 minutes, Bret Nye was located by a probe line. He was found about 50 feet above the toe of the avalanche and under 2½ feet of snow. He was lying on his right side with his head downhill. A small airspace was found around his head, and he was taking shallow, gasping breaths. He was obviously cyanotic (blue-colored from lack of oxygen) but showed a good strong pulse. Mouth-to-mouth resuscitation was applied, followed by oxygen. Within 3 minutes, the victim had regained full consciousness. Further examination and questioning revealed no injuries. Nye was taken to a hospital in Salt Lake City for a complete examination and the rescue was terminated at this point.

Avalanche Data

This avalanche was classified as a SS-AS-3; it fractured up to 4 feet deep and dropped about 350 feet of vertical distance. Nye's Chute is a steep, north-facing slope dropping off the ridge between Hidden Peak and Baldy. This chute had been only lightly skied this particular winter, and considerable depth hoar lay at the bottom of the snowpack. Earlier that day, the chute had been shot, but this failed to release the avalanche.

Comments

This accident is another example of post-control release. The 2-pound hand charge was probably thrown a little too low for maximum effectiveness as the avalanche broke nearly 200 feet upslope of the shot point. As with so many post-control avalanches, this one occurred on a lightly skied slope having a weak substratum (i.e., depth hoar).

The victim is very fortunate to have survived a burial of 75 minutes beneath 2½ feet of snow. From his hospital bed, Nye related that he had at first tried to outski the

avalanche but was overwhelmed and knocked off his skis. He remembered being "real scared" when the snow from above began pouring over him, but still had the presence of mind to pull both arms up in front of his face. This action formed an airspace which, without a doubt, saved his life. The pressure on his

chest was great enough to make breathing very difficult.

Nye also related that he could easily hear the rescuers working over him, but his own shouts for help went unheard. Another example of this oneway propagation of sound through snow is given on No. 69-7.

*2 caught and buried; 1 injured***Weather Conditions**

The storm that began on December 23 (see No. 71-22) continued intermittently through the 31st, dropping moderate amounts of snow daily. The 24-hour new snow depths measured each morning were 6 inches on the 29th, 9 inches on the 30th, and 7 inches on the 31st. Mostly southwest winds had prevailed during this period. The morning of the 31st was mostly clear, and temperatures warmed from an overnight low of -1°F to near 20°F at 1100.

Avalanche control was carried out as usual at Snowbird on the 31st except for the Little Cloud chute in which an 8-pound hand charge was thrown. Cracking and settling resulted from this large charge, but no avalanche released. All runs in the ski area were opened to the public this day.

Accident Summary

The time was about 1150 when a group of eight skiers reached the top of Little Cloud and prepared to ski down the run. Several other skiers were in the area, and there were several sets of tracks down the run. Three of the group entered Little Cloud on a high traverse and were followed by two more members of the party, Mrs. Brown Dunaway and Mrs. Leonard Martin. When Mrs. Dunaway and Mrs. Martin were in the middle of the slope, the snow fractured a few feet above the two women, catching both of them. The three skiers ahead of them had already skied to safety beyond the reach of the avalanche.

Both women were swept downhill on a fast ride through widely scattered timber. Mrs. Martin covered her face with her hands to help her breathe and also tried to swim with the avalanche. She was doing all right until she hit the trees. After a ride of about 500 feet, both women came to rest near the surface of the snow. Both were able to brush away the snow from their faces and call out to other skiers who had witnessed the avalanche. Mrs. Dunaway appeared to be uninjured, but Mrs. Martin had suffered serious injuries, later

diagnosed as a broken arm and several fractured ribs.

Rescue

The Snowbird ski patrol received word of the avalanche at 1200; 15 minutes later, five patrolmen and a doctor were at the scene. Both women were dug out of the snow and later evacuated by helicopter. Several of the eyewitnesses were questioned about what they saw and specifically about whether they saw anyone else caught in the avalanche. They all stated that they saw only the two women caught. However, this was a large avalanche and quite a few skiers were in the vicinity; therefore, the patrol made the quick decision that a full probing of the debris should be undertaken as a safety measure in spite of the eyewitnesses' statements. (Contrast this decision with that made in No. 70-2.)

Within an hour, eight probe lines consisting of about 100 people were coarse-probing the debris. The probe lines were made up of Snowbird ski patrolmen and ski instructors and many volunteers from skiers at Snowbird. By 1700 all of the avalanche debris had been covered, finding only a ski pole and a mitten belonging to one of the two victims. With confidence now that no other victims had been buried in the avalanche, the rescue leader called off the rescue at this time.

Avalanche Data

Little Cloud is a north-northwest-facing slope in Gad Valley just below the ridge connecting Hidden Peak (where the tram unloads) and Twin Peaks. This avalanche was a SS-AS-4; it fractured 4 feet deep along a 150-foot-wide front and ran more than 2000 feet slope distance. The slope fractured a short distance below the large shot hole made by the 8-pound charge 4 hours earlier, indicating that this charge was probably placed too high for maximum effect.

The Little Cloud chute has a steepness of about 35° at its top. It had been lightly skied

this ski season, and a thick layer of depth hoar had developed at the bottom of the snowpack.

Comments

There are many similarities between this accident and the one occurring 4 days earlier (No. 71-22). Both occurred on slopes that were very similar in elevation, steepness, and aspect. These slopes had seen only light numbers of skiers during the young ski season; hence, they had not been stabilized by skier traffic. Both of these accident sites had been hit with explosive charges and produced no avalanches on the morning of the accident.

The prime suspect in both of these post-control avalanches is the depth hoar within the snowpack. As shown by these two accidents, explosive control alone will not solve all

depth-hoar problems. It is sometimes necessary—and desirable—to stabilize by using both explosives and ski traffic. The ski traffic provides stabilization through compaction of the new snow.

The winter of 1971-72 was Snowbird's first year of operation, and the area got off to a late opening. By late December, many of Snowbird's runs had seen very few skiers and, hence, had very little compaction. However, subsequent seasons have seen a large increase in the number of skiers at Snowbird. This has resulted in more ski compaction on many of its runs and a corresponding decrease in the chance of post-control avalanche release. In addition, the ski patrol has gained better information on avalanche release points, insuring more accurate shot placement.

APPENDIX 1

GLOSSARY

- AIRBLAST:** A strong rush of air produced in front of a fast-moving, powder avalanche. Potentially destructive.
- ASPECT (or EXPOSURE):** The direction in which a slope faces. A north-facing slope has a north aspect.
- AVALANCHE:** A mass of snow sliding down a mountain.
- AVALANCHE CONTROL:** Artificial means of releasing an avalanche or stabilizing the snowpack in place. Commonly used methods are protective skiing, test skiing, hand charges, and artillery.
- AVALANCHE HAZARD:** A threat to life and property from avalanches.
- AVALANCHE PATH:** The entire area down which an avalanche moves and made up of the starting zone, track, and runout zone. Also called **SLIDE PATH**.
- AVALAUNCHER:** A commercially available compressed-gas gun which launches an explosive projectile at a distant avalanche slope. Used for avalanche control.
- BELAY:** To secure (a climber or skier) by a rope held firm either by a fixed object or by another person.
- BURIED:** A category of the avalanche toll for an accident. A person is buried in an avalanche if he is completely beneath the snow when the avalanche stops. Persons with only a ski tip or a hand or foot protruding from the snow are considered to be buried. Persons in vehicles or buildings that are completely buried are considered to be buried. By definition, a person who is buried is also considered to be caught. Also see **CAUGHT** and **PARTLY BURIED**.
- CAUGHT:** A category of the avalanche toll for an accident. A person is considered caught in an avalanche if he is in any way involved in the moving snow. Also see **BURIED** and **PARTLY BURIED**.
- CORNICE:** An overhanging mass of snow forming from wind-drifted snow along the crest of a ridge. The steep slope below a cornice is often the starting zone for an avalanche.
- CROWN FACE:** See **FRACTURE LINE**.
- DEBRIS (Avalanche Debris):** A mass of snow, soil, rock, trees, etc., brought down by an avalanche.
- DENSITY (of new snow):** Mass per unit volume of snow, expressed in g/cm^3 or kg/m^3 . The density of water is 1 g/cm^3 or 1000 kg/m^3 . Typical new snow densities range from $.03$ to $.30 \text{ g/cm}^3$ (30 to 300 kg/m^3). See **WATER EQUIVALENT** also.
- DEPTH HOAR:** Large, coarse grains of snow formed by temperature gradient metamorphism within the snowpack. Depth-hoar grains have distinct faces and corners, sometimes appear as pyramids and cups, and can grow to a size of 10mm . Often growing just above the ground where the temperature gradient is largest, depth hoar forms a very weak layer which is highly susceptible to shear or collapse.
- EXPOSURE:** See **ASPECT**.
- FALL LINE:** The steepest or most direct path down a slope; the direction perpendicular to a contour line.
- FRACTURE LINE:** A well-defined line where the moving snow breaks away from the more stable snow above. Also called **CROWN FACE**.
- HAND CHARGE:** An explosive charge thrown by hand onto an avalanche slope. The desired effects are either to release the avalanche or to stabilize the snow in place.
- HOWITZER (or PACK HOWITZER):** A portable military artillery piece for firing an explosive round into a distant target. Both 75-mm pack howitzers and 105-mm howitzers are used for avalanche control.
- INJURED:** A category of the avalanche toll for an accident. Self-explanatory.
- KILLED:** A category of the avalanche toll for an accident. Self-explanatory.
- LEE (side of a slope):** The side sheltered or protected from the wind. An east-facing slope is in the lee of a west wind. Opposite of **WINDWARD**.
- PARTLY BURIED:** A category of the avalanche toll for an accident. A person is partly buried in an avalanche if he is covered by snow anywhere from the ankles to the neck when the avalanche stops. By definition, a person who is partly buried is also considered to be caught. See also **CAUGHT** and **BURIED**.
- PROBE LINE:** A line of rescuers, formed along a contour and facing uphill, organized to probe the snow with poles to locate an avalanche victim.
- PROBE POLE:** A lightweight metal pole used to penetrate the snow to locate an avalanche victim.
- PROTECTIVE SKIING:** Deliberate day-to-day skiing of avalanche slopes to stabilize

- the snowpack. The starting zone is cut several times in a criss-cross pattern to break up the slab. Protective skiing is ineffective and not recommended on hard slab. Compare with TEST SKIING.
- RECOILLESS RIFLE:** A military artillery piece, with severe backblast which eliminates recoil, for firing an explosive round into a distant target. Mounted either on a permanent platform or on the bed of a vehicle, both 75-mm and 105-mm rifles are used for avalanche control.
- RUNOUT ZONE:** The lowest part of an avalanche path where the avalanche debris stops because of a decrease in slope angle or a natural obstacle.
- SHEAR:** Stress applied to a body in such a way that equal and opposite forces are exerted on its ends along different lines of action, thereby tending to change the shape of the body without changing its volume. For example, shear stress will tend to deform a square-shaped body (viewed from the side) into a parallelogram-shaped body. In a snow slab, the slope-parallel component of gravity tends to pull the slab downhill while friction and cohesion between snow surfaces acts to hold the slab in place. Slippage between the slab and its under-surface can result, and failure can occur if shear stress exceeds shear strength. Compare with TENSION.
- SLAB:** A layer of snow characterized by internal cohesion between snow grains.
- SLIDE PATH:** See AVALANCHE PATH.
- SLOPE DISTANCE:** The length (of an avalanche) measured on or parallel to the surface of the ground.
- STABILIZE:** To compact the snow or relieve stress in the snowpack and thereby reduce the chance of avalanche release. Stabilization can occur naturally with time or can be effected with avalanche control.
- STARTING ZONE:** The area where an avalanche releases. Also called loading zone, catchment basin, release area, fracture zone.
- STUDY PLOT:** A site at which precipitation, temperature, and snow cover measurements are taken daily. These data are used with other measurements, such as wind, to estimate hazard.
- TENSION:** Stress applied to a body in such a way that equal and opposite forces acting away from each other are exerted on its ends along the same line of action, thereby tending to elongate the body. A snow slab is placed in tension by the slope-parallel component of gravity tending to pull the slab downhill while its anchor points and the cohesion between grains try to hold it in place. A slab can fail in tension when tensile stress exceeds tensile strength. Compare with SHEAR.
- TEST SKIING:** An attempt to release avalanches on selected small slopes by skiing across the normal fracture zones. Test skiing is used as an indicator of hazard buildup and the possible need for more control measures. Compare with PROTECTIVE SKIING.
- TOE (of an avalanche):** The tip of the avalanche debris after an avalanche has come to a stop. The toe marks the farthest extent of the sliding snow.
- TRACK:** The middle part of an avalanche path below the starting zone and above the run-out zone.
- TRANSITION (of a slope):** A sharp change in the steepness of a slope. Going down the slope, a transition to a flatter area is called a *bench* or *step*; a transition to increased steepness is called a *roll*, *drop-off*, *cliff*, etc.
- UNSTABLE (slab or snowpack):** Near the point of failure; stress and strength of the slab are very nearly equal. Additional snow loading, an explosive charge, a skier, or the like could cause avalanche release.
- VERTICAL FALL DISTANCE:** The drop in elevation of an avalanche from the starting zone to the toe of the debris.
- WATER EQUIVALENT:** The liquid water content of a given amount of snow, measured in inches. Usually determined by weighing.
- WINDWARD (side of a slope):** The side facing into the wind. Opposite of LEE or LEEWARD.

APPENDIX 2

AVALANCHE CLASSIFICATION

The avalanche classification used in this volume is the standard avalanche classification used in the United States. Five elements of an avalanche are covered: type, trigger, size, sliding surface, and airblast, in that order.

Type; HS = hard slab, SS = soft slab, WS = wet slab, L = loose snow, WL = wet loose.

Two principal types of avalanches are recognized: loose snow and slab avalanches. *Loose-snow* avalanches are characterized by cohesionless snow; they originate from a point and fan outward as they flow downhill. *Slab* avalanches are characterized by cohesion between the snow grains; they originate from a well-defined line called a fracture line (or crown face). Slab avalanches are further subdivided into *soft-slab* and *hard-slab* avalanches, depending on the density and degree of cohesion of the snow. The distinction between soft slab and hard slab is often difficult to make. Usually, however, a soft-slab avalanche disintegrates into loose material while sliding downhill; a hard-slab avalanche contains large chunks or angular blocks of snow in the debris. The density of hard slab is usually $\geq .30$ (30% the density of water or $.30 \text{ gm/cm}^3$ or 300 kg/m^3). Both loose-snow and slab avalanches are classified as *wet* if free water is present in the snowpack or if the debris is obviously refrozen when inspected several hours after the event.

Trigger: N = natural release; AS = Artificial, ski release; AE = artificial, hand charge (explosive); AA = artificial, artillery; AL = artificial, avalauncher; and AO = artificial, other, a miscellaneous category of artificial triggers which includes snowcats, snowmobiles, persons on foot, snowshoes, artillery backblast, etc.

Size: The size of an avalanche is designated with a number scale ranging from 1 to 5. A size 1 avalanche, or sluff, is any snowslide running less than 150 feet slope distance (ap-

proximately 75 to 100 feet vertical) regardless of its other dimensions such as width, fracture line, etc. All other avalanches are classified by a number 2 to 5 that designates their size, with larger numbers indicating larger sizes. This size classification is based on the concept that size should convey an estimate of the volume of snow that is transported down an avalanche path rather than an estimate of threat to life or property. In addition, sizes 2 to 5 are reported relative to the slide path. A "small" avalanche is one that is small (moves a small volume of snow down the path) for the particular avalanche path; a "large" avalanche is large (moves a large volume of snow down the path) for that path.

With these specifications in mind, the avalanche size classification becomes:

- 1 = a sluff, or snowslide less than 150 feet slope distance (approximately 75 to 100 feet vertical) regardless of volume of snow
- 2 = small, relative to the avalanche path
- 3 = medium
- 4 = large
- 5 = major or maximum

Sliding surface: O = an avalanche that ran on an old snow surface in the starting zone (surface avalanche); G = an avalanche that ran to the ground in the starting zone (ground avalanche).

Airblast: J indicates airblast, the potentially destructive strong wind that may extend well beyond the visible dust cloud or moving snowfront. Airblast occurs only with large, fast-moving avalanches.

Examples: SS-AS-2 = a small soft slab released by a skier; SS-AE-4-0-J = a large soft slab released by a hand charge, ran on old snow surface with airblast; HS-AO-3-G = a medium-size hard slab released by a miscellaneous artificial trigger, ran to the ground; L-N-1 = natural loose snow avalanche running less than 150 feet slope distance (a sluff).

APPENDIX 3

ON AVOIDING AND SURVIVING AVALANCHES

The accidents in *The Snowy Torrents* provide an excellent sample that identifies likely avalanche victims, shows how and why victims get themselves in trouble, and points out which activities may lead to avalanche encounters. Almost half the accidents (35 of 76) reported from 1967-71 occurred within ski areas; these included both recreational skiers and ski patrolmen. An additional 12 accidents involved ski tourers. Hence, approximately 60 percent of the accidents involved skiers, and assuming this ratio to be valid for the long term, skiers as a group are more likely to run afoul of avalanches than anyone else. (If one considers all the minor accidents that occur each winter but are not documented, the ratio of skiers to the total number of persons caught would be considerably higher than 60 percent.)

Climbers, hikers, and snowmobilers also are enthusiasts whose recreation may lead them into avalanche encounters. But persons not at play may also become avalanche victims, as shown by the accidents involving people at work, motorists, and occupants of homes or cabins.

The whole key to reaching these various interest groups and saving lives lies in public education. By drawing on the experience of others, this Appendix serves to increase avalanche awareness and prescribes rules of safety for avoiding and surviving avalanches.

Avoiding avalanches

The basic guidelines for avoiding avalanches are simple and involve only common sense and a little acquired knowledge and experience. Persons who expect to encounter avalanches in recreation or work should develop the skills to make a few elementary observations of evidence of avalanches and to evaluate snowpack stability, or know to whom to turn for such information. In short, they need to know when and where skiing, travel, work, etc., is safe in mountainous terrain.

1. Sources of avalanche information:

Information on current avalanche conditions is available from several sources. Contact local U.S. Forest Service or National Park Service offices and ski area patrols for the latest avalanche information; listen for weather reports over radio and television for the latest weather. In some parts of the coun-

try (the Rockies of Colorado, the Wasatch Range of Utah, and the Cascades of Washington), avalanche warnings are issued jointly by the Forest Service and National Weather Service. These warnings are broadcast over radio and television and provide the listener with information during dangerous periods.

When skiing within developed ski areas, the procedure for obtaining information is simple: ask the ski patrol which slopes are open and do not violate avalanche closure signs. There are an ample number of accidents (Nos. 68-8, 69-18, and 71-14 to name a few) to illustrate that avalanche closures are purposeful and to violate them is to invite trouble. (Ski areas, too, have a responsibility to the skiing public not to abuse avalanche closures by applying them at times when no avalanche hazard exists or at places where the reason for closure is other than avalanche hazard. Skiers will soon realize that the ski area is merely "crying wolf" with such closures and will no longer respect these closures.)

2. Identification of avalanche areas and dangerous conditions:

Safe travel outside ski areas requires a knowledge of terrain, weather, and stability evaluation. Avalanche paths are usually iden-

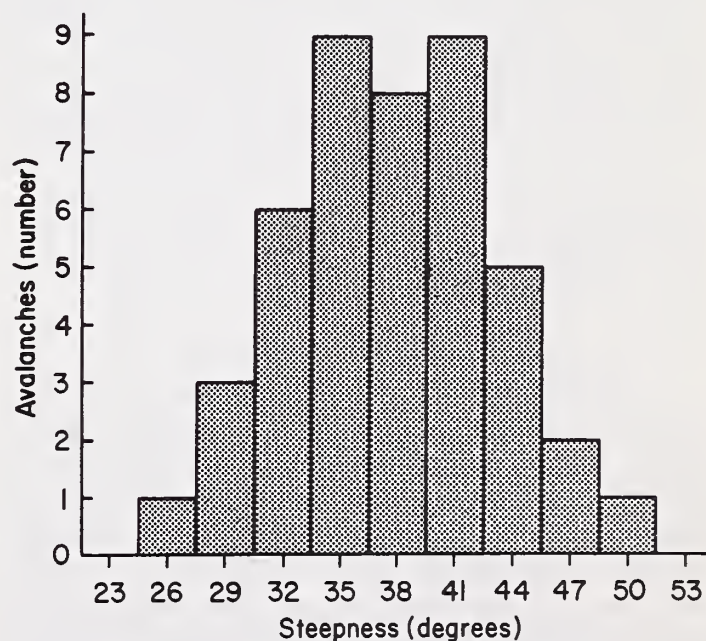


Figure 3.1. Frequency diagram of number of avalanches per 3-degree classes of starting zone steepness. Based on data from the accidents in this volume.

tifiable by avalanche debris, a trimline of trees along the edges of the path, bent-over trees, or damaged trees. A recent publication by M. Martinelli, Jr., *Snow avalanche sites: their identification and evaluation* (Agriculture Information Bulletin 360), contains many good photographs of avalanche paths and offers guidelines for identification. This publication is available from the Superintendent of Documents for 50 cents.

The best indication of instability (i.e., dangerous conditions) is recent avalanche activity. Other indications are hollow sounds beneath feet or skis (see No. 67-10 for example), collapse of the snow beneath the feet, and cracks in the snow shooting ahead and behind. "Talking" snow such as this is highly unstable.

3. Avalanches related to slope steepness and aspect:

There is a definite relationship between avalanche occurrence and slope steepness. Avalanches occur most frequently on slopes of 30° to 45°. Figure 3.1, based on the accidents in this volume, graphically reveals this fact. Snow-country travelers should bear this information in mind.

There is a much less definite relationship between avalanche occurrence and slope aspect. The avalanches in this volume do show a strong bias toward occurrence on north-facing slopes; however, about half of these accidents occurred in ski areas, and ski areas have predominantly north-facing slopes. If ski-area accidents are excluded from the sample, the back-country accidents show a more even distribution on all aspects. Accidents occurring on north and east exposures are only slightly more numerous than those occurring on south and west exposures. The important thing to remember here is that avalanches can release on slopes of all aspects. Especially when major storms are in progress, all slopes may be equally unstable.

4. Avalanches related to storms:

A most important point is that most avalanches, and consequently avalanche accidents, occur during or within 24 hours of a storm, and are thus called direct-action avalanches. Indeed, 85 percent of the accidents in this volume occurred during or after storms. It is also important to remember that storms need not be large to produce dangerous conditions; a few inches of snow with strong winds can produce dangerous slab conditions on lee slopes. Accident No. 69-4 is an example of such a "setup" condition. The

moral is that one should be extra cautious if snow has fallen within 24 hours, especially if accompanied with strong winds. Unfortunately, good powder skiing and avalanches go hand-in-hand.

5. Route selection and safe travel:

There are few hard and fast rules of route selection when traveling in avalanche country. Whether on foot, snowshoes, skis, or snowmobiles, travelers are usually forced to choose a route that is a compromise between the more efficient (more direct, least exhausting, etc.) and the safest. It is best to avoid dangerous slopes altogether; this is done by staying on valley floors, ridgetops, slightly on the windward sides of ridges, or in dense timber. Often, however, it is necessary to cross a dangerous slope, and it is here that a few safety guidelines need be applied.

a. Initially, the decision must be made whether to cross, to alter the route, or to turn back. Signs of instability, wind slab, or heavy snow or rain indicate that the prudent decision is to turn back or alter the route.

b. If the crossing must be made, cross very high (above the normal starting zone) or very low (in the runout zone). Avoid traversing the starting zone or middle of the track. This is a common-sense application of avalanche awareness: when crossing the starting zone or mid-track, one runs a high risk of triggering the avalanche himself and getting caught; when crossing the runout, one only runs the risk of getting caught by a natural release from above.

c. If a starting zone must be traversed, cross as high as possible. Should the slope fracture, most of the sliding snow lies below the victim; thus he has a better chance of staying on the surface. A victim low on the slope is in a very poor position, as shown by numerous examples (Nos. 67-3, 68-9, 70-2 and 71-18 to name a few).

d. If a starting zone must be climbed or descended, keep far to the sides. Should the slope fracture, the victim has a better chance of bailing out to the side of the avalanche.

e. Cross an avalanche slope one person at a time, all other members of the party watching from a safe location. If the slope is especially wide, traversing members should be spaced several hundred feet apart. All persons should traverse in the same track. These precautions insure that if an avalanche releases, no more than one member of the party will be caught and all other members will be available as rescuers. It is not uncommon for

the second, third, or even tenth member of a group skiing down or traversing a slope to be the one to trigger the avalanche (see Nos. 67-3, 68-9, 71-23 for example), so all members should exercise caution. By traversing in the same track, less snow is being disturbed, thus the chance of triggering the avalanche is minimized.

f. Use a climbing rope for belay when crossing an especially dangerous slope (one which offers no escape route and which may sweep the victim into a gully or crevice or over a cliff).

Safety measures and equipment

Persons who are exposed to avalanches from time to time can take several precautions in addition to common sense thinking and proper route selection to improve their chances if caught and buried. Before entering an avalanche slope, tighten all clothing, zipping up zippers and pulling cap on tight. This will insure some degree of warmth if buried. If carrying a heavy pack, loosen the shoulder straps or even sling the pack over one arm so that the pack can be easily shed if caught.

If on skis, remove the ski pole wrist straps so that poles can be thrown away. It will be much easier to swim with the avalanche if the hands are free. Removing ski safety straps is an arguable point that has both pros and cons. On the one hand, the avalanche victim wants first to ski to the edge of the slide if possible; having skis on is mandatory for this escape. Also, having skis still attached to a buried victim serves two purposes: first, there is the chance that a ski tip will protrude from the snow making for a quick rescue (No. 71-20 for example); and second, skis provide two more objects for probes to strike while searching for the victim (No. 67-1 for example). On the other hand, shedding skis makes it much easier for the victim to use his legs while swimming with the avalanche (No. 68-4 for example). Attached skis may also pull the victim to a deeper burial, as well as increase the chance of injury from a windmilling ski.

Of the equipment that one can carry with him, an avalanche rescue beacon such as a Skadi offers by far the best chance of a live recovery. To be effective, each member of a party must be equipped with one of these transceivers and must have received practice using them according to the directions supplied with each unit. The party must also be equipped with shovel (see below) for digging down quickly to a buried victim.

An avalanche cord is another safety de-

vice that should be employed. Accident No. 69-21 demonstrates its worth. The use of avalanche cords, however, is far from foolproof; the entire length of cord may be buried along with the victim (see Nos. 69-7 and 69-20).

Standard rescue equipment carried by back-country travelers should include probes and shovels. Ideally, each member of the party should carry a collapsible or sectional probe pole. At least one member of the party should carry a lightweight, collapsible shovel.

Surviving avalanches (if you are the victim)

While sitting back in an easy chair, it is easy to think calmly about the things an avalanche victim should do to help himself. In reality, however, a victim must try to make rational decisions all in a split second while at the same time fighting the panic that is natural to his situation. Experience may be a good teacher, but all too often a victim's first avalanche experience is his last. A person, however, can give himself a measure of safety by being in good physical shape to begin with, by committing to memory some of the survival rules, and by anticipating trouble before entering a dangerous slope and having an escape route in mind.

Whether on foot, skis, or snowmobile, the victim's first move after being caught should be to try to escape to the side of the avalanche (or grab any tree that might be handy). This is more easily done if he can stay on his feet or machine. He should also be very conscious about clamping his mouth shut and breathing through his nose. Trying to gulp air through his mouth while submerged or partly submerged will only result in a mouthful of snow that becomes almost impossible to expel (see No. 68-4) and can hasten suffocation if completely buried.

If knocked off his feet, the victim should then put all his effort into swimming with the avalanche. The effectiveness of swimming has been documented throughout this volume (Nos. 67-3, 68-4, 68-9, 69-1, 69-21, 70-1, 71-12, and 71-23). A skier should rid himself of his ski poles (wrist straps should have been removed earlier) and begin swimming motions with his arms. He should also kick as best he can with his legs (if his skis have been ripped off, this will be easier). If the victim has been thrown forward and is being carried headfirst downhill, a breast stroke with the arms seems to be effective (see No. 68-9). If he is being carried feet first downhill, he should try to roll onto his back and attempt to "tread water" with his arms and legs (see Nos. 67-3 and 69-21). With

these motions, the victim has some control over his depth and direction of movement in the avalanche. (If, however, the avalanche is large and turbulent, the victim will probably be rendered helpless.)

When the avalanche begins to slow to a halt, the victim should make every effort to reach the surface by thrusting upward with swimming motions. He should try to place one or both hands in front of his face and move his head and arms back and forth to create a breathing space before the slide has stopped. This may be very difficult to do but can be a lifesaving effort (see Nos. 67-1, 68-9, 70-3, 71-5, and 71-22). Another lifesaving gesture is to thrust upward with one hand (or ski pole) in an effort to break through to the surface. Accident Nos. 67-9, 68-9, and 70-3 demonstrate the value of this action.

If the buried victim can move in any way, he should do so to improve his position. If he is oriented so that he knows up from down or can see a hint of daylight, he should work toward reaching the surface. If he is completely pinned, he should try to stay calm, conserving his breath and energy, and await his rescuers.

Rescue (if you are the survivor)

The survivors of, or eyewitnesses to, an accident need to act quickly and with author-

ity, for their actions over the next several minutes may mean the difference between life or death for the victim. They should first mark the last-seen point of the victim and begin their search directly downhill from that point. Use the avalanche rescue beacon if the victim was so equipped. Otherwise, work downhill quickly, searching for clues and scuffing and probing the snow with probes, skis, and ski poles.

If the accident occurred in or very near a ski area, one of the rescuers should notify the ski patrol immediately, for a large body of rescuers is available only minutes away. If the accident occurred in the backcountry, all rescuers should search and probe the area as thoroughly as possible before sending for outside help, which probably lies several hours away.

Rescuers need to familiarize themselves with the statistics of Appendix 4, especially noting that after a burial of only 30 minutes, a victim's chance of survival falls below 50 percent. Time is, therefore, of the essence in all avalanche rescues. Rescuers should also be fully aware, however, that fortunate circumstances can allow the victim many hours of life (see No. 67-2 for example). Thus, never abandon a rescue prematurely; give the victim every possible chance.

APPENDIX 4

THE DEADLY STATISTICS OF AVALANCHE BURIALS

A sample of 121 avalanche burials has been compiled from documented accidents from 1910 to 1974. This includes accidents from this volume, from the original *The Snowy Torrents*, and from 1972 to 1974. The purpose here is to determine the diminishing probability of survival with time; i.e., just how long can a buried avalanche victim be expected to live?

The answer to this question depends on many factors—injury, depth of burial, snow density, position of the victim, presence of airspace, size of airspace, etc. The combinations are almost endless, and it is these factors that determine whether a victim lives for several hours or dies within a few short minutes. A victim's rescuers cannot know which factors are at work in any given burial, so they must be aware of the cold, hard statistics of survival based on a large number of cases.

Figure 4.1 plots the 121 cases on a graph of

depth vs. burial time. All victims included were completely buried, with the exception of a few cases where a ski tip, pole, hand, or foot was visible. But even in these cases, the victim's head was buried beneath the snow, he was unable to dig himself out, and his survival depended on a quick rescue. No victims buried in the wreckage of buildings or in vehicles are included in this sample for the reason that such victims can be shielded from the snow to allow sizable airspaces. The sample is, therefore, not biased by this extreme circumstance. (Colin Fraser in his book *The Avalanche Enigma* recounts the saga of a young Austrian man who survived a burial of 12½ days in the ruins of a small hut.)

Of principal interest in Figure 4.1 is that only 39 of 121 victims survived; hence, a completely buried victim has one chance in three of survival, regardless of all other considerations. Two points of further interest are that

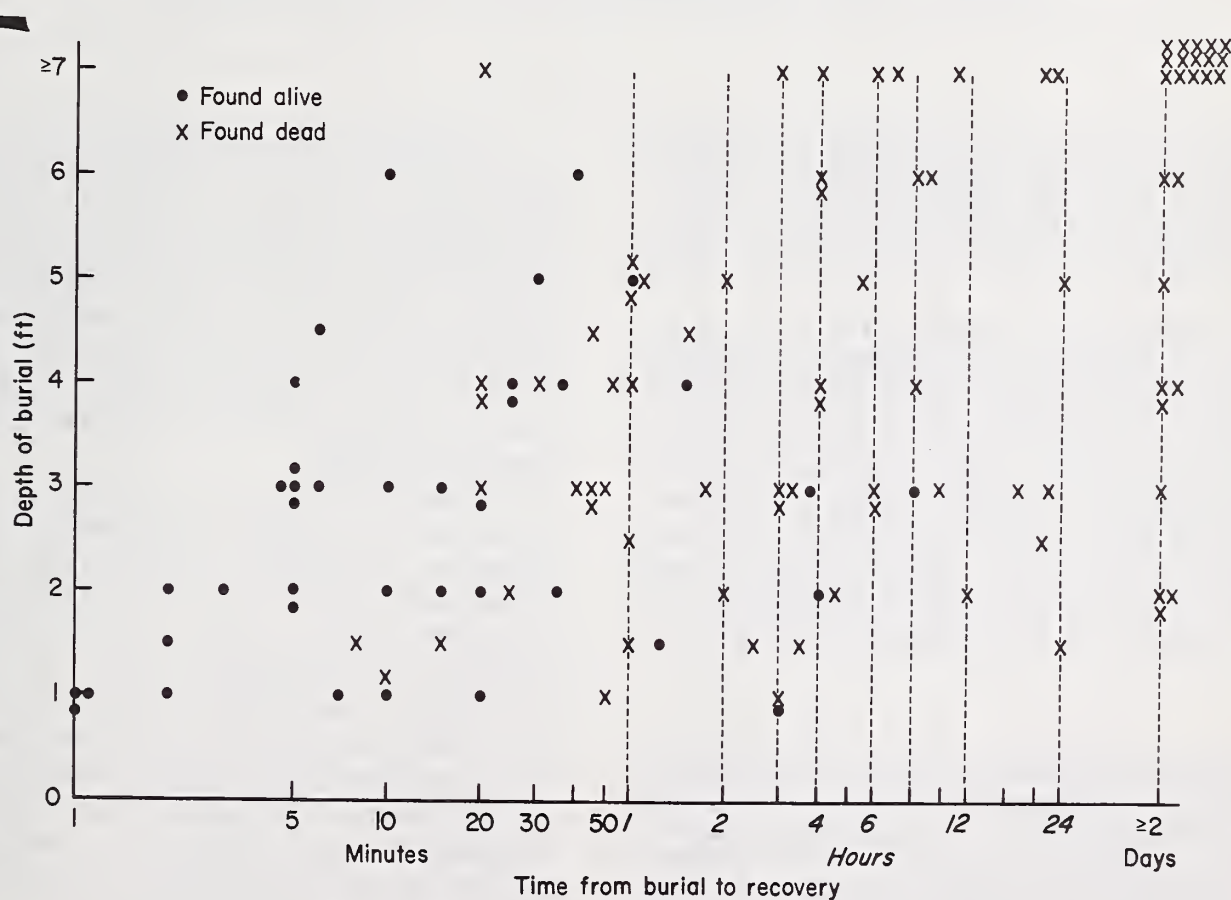


Figure 4.1. 121 buried victims of avalanches plotted on a graph of depth of burial vs. elapsed time from burial to recovery. Based on a sample of avalanche accidents in the U. S. from 1910-74. A solid dot indicates the victim was found alive; an X indicates the victim was found dead.

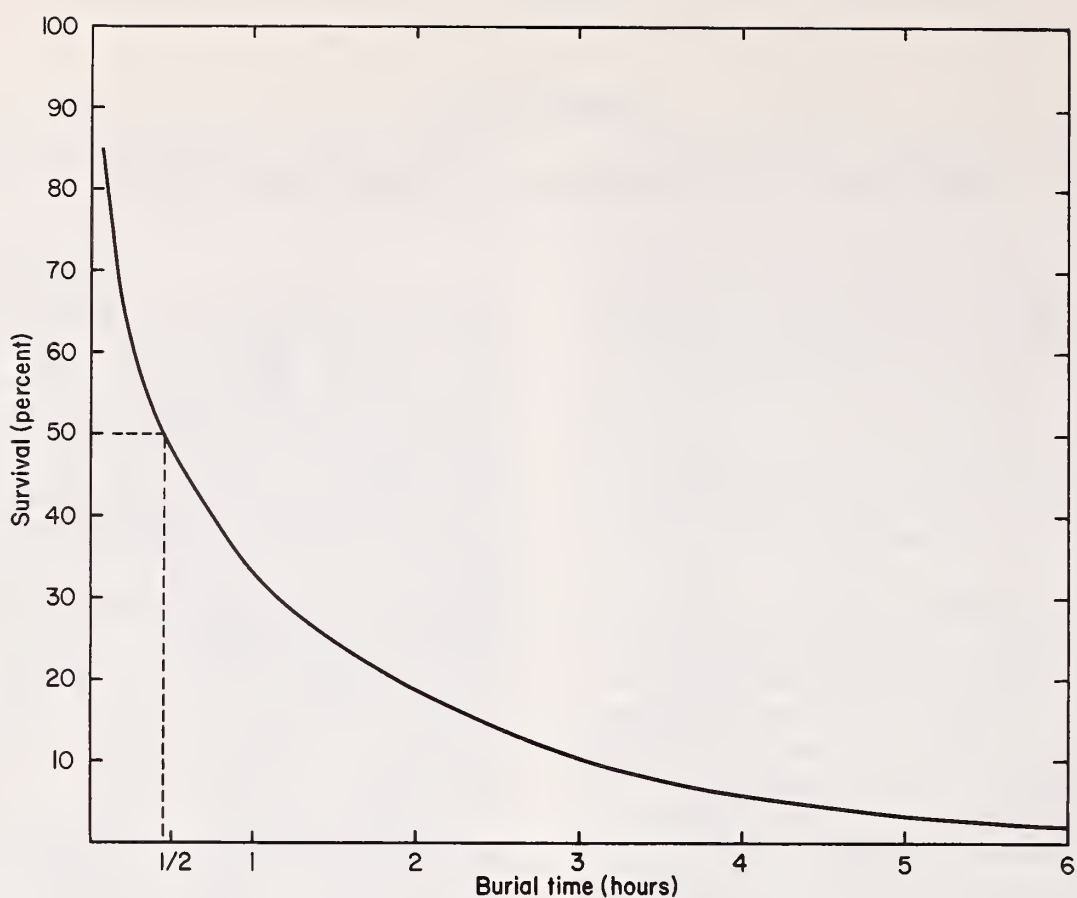


Figure 4.2. Percent survival among avalanche victims vs. elapsed time of burial. Based on a sample of avalanche accidents in the U. S. from 1910-74. Note that the 50% survival time is about 1/2 hour (30 minutes).

no victim survived a burial deeper than 6 feet and that no one was recovered alive after being buried more than 8 hours. These, then, are the limits of the "life zone" in this sample. *

The crucial figure derived from the data, however, is Figure 4.2. This gives the harsh statistics relating chance of survival to burial time. Take a look at this figure, especially noting that *the median or 50% survival time is about 30 minutes*. In other words, after a burial of 30 minutes, only 50 percent of the victims can be expected to survive. The message is clear: *time is of essence in avalanche rescue*. Rescuers must be keyed in to this fact.

*There are several documented cases that have occurred outside the United States in which victims buried completely and in direct contact with the snow have survived for more than 8 hours. One remarkable case occurred in January 1960 near Invermore, British Columbia, Canada. James Duke, 59, a Department of Highways employee, was swept away and buried while acting as an avalanche lookout for a work crew. Defying all odds, he was found alive 25½ hours later beneath 5 feet of snow. An airspace the "size of a washtub" around his head saved his life.

A number of years ago, the time limit for 50 percent survival was believed to be about 2 hours. Rescues were planned accordingly, with efforts to locate the victim in 2 hours or less. In 1968, the U.S. Forest Service published *Modern Avalanche Rescue* which revised the time limit for 50 percent survival down to 1 hour. To meet this goal, a three-stage rescue was proposed, with emphasis on speed for the first two stages.

Now, however, the statistics reveal the 30-minute time limit. This has strong implications on avalanche rescues both within ski areas and without, the burden of speed being more important than ever. The three-stage rescue for organized units, as proposed in *Modern Avalanche Rescue*, can be made to meet this deadline. Stronger emphasis, however, is placed on the hasty search unit (stage 1) than before. This group must have adequate manpower and equipment to perform an initial hasty search and probe, all within a shorter time span than ever before. For back-country rescues, the message is clear and blunt: *virtually the only chance a buried victim has to live is to be found by his compan-*

ions. The necessity of seeking outside rescue units in effect assumes that a dead recovery is all that can be expected. Thus, back-country travelers should always be prepared for such emergencies. Avalanche rescue beacons (such as Skadis) or collapsible probe poles are mandatory equipment for back-country trips that intersect avalanche terrain.

These are very sober thoughts, but

thoughts that must be realized by back-country travelers and rescuers alike. A further thought, however, is that rescuers must never abandon their search prematurely. Figure 4.2 shows that even after 6 hours, approximately 2 to 3 percent of the victims, or about 1 in 40, can be expected to be found alive, and no avalanche victim should ever be denied this small chance at life.

APPENDIX 5

AVALANCHE ACCIDENT REPORTING FORM
(Attach additional pages whenever needed)

I. General information

1. Date: _____ 2. Time of accident: _____

3. Exact location:

4. Victim(s)

Name	Age	Address & Phone	Conditions/injuries
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5. Eyewitnesses or other members of party

Name	Age	Address & Phone
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6. Damage to vehicles, buildings, lifts, etc. (Itemize and give dollar estimate of loss)

II. Accident summary

1. Events leading up to accident (General description of circumstances and events including objective of party, departure point, route taken, etc.)

2. Accident account (Eyewitness account or observer's deductions based on tracks and other evidence. Important points are: how slide was released, location of victim(s) at release, last seen point, etc.)

III. Rescue (Time and names are important)

1. Time report of accident received and from whom:_____

2. Hasty party

Time dispatched:_____ Leader's name:_____

Number in party:_____ Time arrived at site:_____

3. Followup (main) party

Time dispatched:_____ Leader's name:_____

Number in party:_____ Time arrived at site:_____

4. Description of search procedures (including location of clues, etc.):

5. Time, location, and position of victim(s) when found:

6. Depth of victim(s), length of time buried, condition and injuries:

7. Cause of injury or death (For fatalities, include coroner's report, if available):

8. Time rescue was concluded: _____

9. Other pertinent information:

IV. Weather and snowpack data

1. Weather synopsis (include instrument data readings when available):

2. Snowpack structure:

3. Were warnings, restrictions, or closures in effect?

V. Avalanche data

1. Type of slide (classification): _____

2. Dimensions: width _____; length (indicate either vertical or slope distance) _____

3. Fracture line: depth _____ length _____

4. Depth of debris: _____

5. Other pertinent information: _____

VI. Terrain data

1. Elevation: _____ 2. Aspect: _____
3. Starting zone slope angle in degrees: _____
(Add "M" if measured, "E" if estimated)
4. Vegetative cover (open, timbered, etc.): _____
5. Shape of path (open slope, gully, etc.): _____

VII. Conclusions (cause of accident, etc.) and recommendations:

Signed _____

Address _____

The following attachments should be included whenever possible:

1. A full narrative summary of the accident and rescue.
2. A vicinity map showing location of accident relative to the nearest town or landmark.
3. A detailed map or diagram with scale, legend, and north direction arrow and showing slide area, fracture line, deposition zone, landmarks, victim's (and others) route, positions of all persons at time of accident, last seen point(s), location of clues, area probed, where victim(s) found, and location of closure signs (if applicable).
4. First-person statements of survivors or eyewitnesses.
5. Photos.
6. Newspaper stories.



