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AVALANCHE ACCIDENTS IN CANADA
I. A SELECTION OF CASE HISTORIES
OF ACCIDENTS, 1955 TO 1976

ANALYZED

by C.J. Stethem and P.A. Schaerer

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ABSTRACT

Case histories are presented of avalanche accidents in Canada that resulted in death, injury or serious destruction of property in the years between 1955 and 1976. They contain a description of the circumstances leading to the accident, the event, and the rescue operation, but they do not include all accidents owing to insufficient information. Whenever possible, weather observations at the closest climatological station are given for the day of each accident and those preceding it. Compilation of case histories will continue and publication of a second volume is anticipated.

ACCIDENTS CAUSÉS PAR DES AVALANCHES AU CANADA

I. CHOIX DE CAS DOCUMENTÉS D'ACCIDENTS DE 1955 À 1976

par C.J. Stethem et P.A. Schaerer

RÉSUMÉ

On présente des cas documentés d'accidents causés par des avalanches au Canada qui provoquèrent la mort, des blessures ou de graves dommages des biens des personnes, des années 1955 à 1976. On décrit les circonstances qui menèrent à l'accident comme tel, et l'opération de sauvetage, mais tout les cas ne sont pas rapportés à cause d'un manque d'information. Lorsqu'il est possible, des observations sur le temps à la Station météorologique la plus proche sont données pour le jour de chaque accident et pour les jours qui précédèrent. La compilation de ces cas documentés sera poursuivie et on prévoit publier un deuxième volume.

FOREWORD

Knowledge is gained from our mistakes and the mistakes of others. It was with this in mind that the Division of Building Research of the National Research Council of Canada arranged for a collection of case histories of avalanche accidents resulting in death, injury, or serious destruction of property.

The accident histories contained in this report were collected by Mr. Chris Stethem, working on Contract No. 032-502 with the National Research Council. Mr. Stetham obtained the information from published reports, from files of agencies, and through interviews with people who were either eyewitnesses of the accident or involved with the rescue operation. As many technical details as possible are included, but in some cases important information, for example, the depth of burial of a victim, the number of people involved in the search, or the snow conditions responsible for the avalanche, could not be found.

The compilation of case histories will continue and the publication of a second volume is anticipated, with additional cases from earlier years, together with the avalanche accidents since 1976. The assistance of National Parks personnel and others is gratefully acknowledged.

Ottawa
February 1979

C.B. Crawford
Director, DBR/NRC

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Garibaldi Lifts Ltd.

Metropolitan Toronto Police

Parks Canada

Red Mountain Ski Club

Royal Canadian Mounted Police

Sureté de Québec

Whitewater Ski Society

LIST OF THE ACCIDENTS

11 July	1955	Mount Temple	Mountain climbers killed
11 March	1956	Marmot Basin	Skier killed
17 March	1957	Richardson Ridge	Skier killed
23 November	1958	Bow summit	Skiers killed
30 January	1960	Toby Creek	Person on a road buried
23 May	1960	Mount Athabasca	Mountain climbers injured
20 June	1960	Mount Athabasca	Mountain climber injured
30 December	1962	Mount Whaleback	Skier killed
28 April	1963	Temple Ski Area	Skier buried
18 February	1965	Granduc Mine	Workmen killed, mine camp destroyed
28 February	1965	Mount Norquay	Skier killed
28 December	1965	Kootenay Pass	Person on road killed
8 January	1966	Rogers Pass	Workmen killed
30 January	1967	Mount Whitehorn	Skier killed
16 March	1967	Kootenay Pass	Person on road buried
9 December	1967	Parker Ridge	Skier killed
23 March	1969	Mount Hector	Skier killed
24 January	1970	Deception Pass	Skier buried
24 January	1970	Westcastle	Skier killed
6 June	1970	Deception Bay	Tank farm damaged
7 December	1970	Ruth-Vermont Mine	Building damaged
23 December	1971	Granite Mountain	Skier killed
24 December	1971	Flathead Valley	Persons on road killed
5 February	1972	Scarborough	Tobogganers killed
19 February	1972	Mount Edith Cavell	Mountain climbers killed
1 March	1972	Sunshine Area	Building destroyed, cars buried
5 March	1972	Giant Mascot Mine	Persons on road killed
8 April	1972	Whistler Mountain	Skiers killed
23 April	1972	Apex Basin	Skier killed
17 February	1973	Whistler Mountain	Skier buried

9 December 1973	Bow Summit	Skier killed
16 January 1974	Ruth-Vermont Mine	Buildings destroyed
22 January 1974	North Route Cafe	Persons in building killed
17 February 1974	Mica Mountain	Skier killed
30 March 1974	Sunshine Area	Skier killed
16 March 1975	Granite Mountain	Skiers injured
16 March 1975	Red Mountain	Skier buried
14 January 1976	Cap Santé	Tobogganer killed
16 January 1976	Kootenay Pass	Persons on road killed
23 March 1976	Paradise Basin	Skier killed

PREFACE

Avalanches usually have natural causes, but they are sometimes triggered by their victims and this is true of most skiing avalanche accidents. The case histories presented in this publication contain a description of the circumstances leading to the accident, the event, and the rescue operation. They cover the years between 1955 and 1976, but do not include all the avalanche accidents that have occurred in Canada during that period owing to insufficient information. Numerous encounters not recorded here have occurred every winter; skiers have been carried down by avalanches and escaped without injury, or vehicles have been caught on roads, their occupants left unharmed. Although these near-accidents would be instructive, they have been omitted because they were usually not adequately documented.

Weather observations at the closest climatological station are given for the day of the accident and those preceding it. Snowfall and temperature at these stations are an indication of the conditions at the accident sites, although owing to distance and differences in elevation they may not be exactly the same.

Almost one-half of the accidents described in this publication occurred in National Parks. One reason for this is the obvious one that skiers and mountain climbers tend to concentrate there. Another factor is the detailed records that are maintained by well-trained and equipped Parks personnel as part of their effort to increase safety consciousness in avalanche terrain. These were made available for the present study.

Seven mountain climbers killed, two injured

WEATHER

Observations at Lake Louise Townsite, 1530 m ASL

Date	Temperature °C		Precipitation
	Max	Min	mm
7 July	14.5	9	2.3
8 July	15.5	6.5	2.3
9 July	21	4.5	
10 July	22	1.5	
11 July	24.5	3	

11 July was a warm, sunny day in the Lake Louise area.

ACCIDENT SUMMARY

A group of 24 teenage youths from a wilderness camp in the eastern United States had camped at Moraine Lake, intending to hike and climb in the area. On 11 July 18 of them started climbing the south face of Mount Temple from a point just below Sentinel Pass on the Moraine Lake Valley side. All were inexperienced in rock climbing.

Half way to the mountain the two group leaders and five others decided that the climb was too difficult for them and that they would not continue. The eleven other boys proceeded, roped at 5-ft (1.5 m) intervals on a 9 mm manila rope. At approximately the 2750 m level they found that the route was too dangerous and started to return, but in crossing a snow slope they were caught by an avalanche and swept down. The time was approximately 1600 h.

RESCUE

The rope to both the lead and tail men broke as the party was swept down, and the two managed to stay on the surface uninjured. In a state of shock, they walked to Moraine Lake Chalet where they reported the accident at approximately 1730 h.

The manager of the Chalet immediately notified the National Park Warden Service, and an advance party of two wardens and a doctor left Moraine Lake Chalet at 1910 h, arriving at the accident site at 2130 h. A follow-up party of 20 men left at 2145 h.

The advance party found three boys dead as soon as they arrived and at 2145 h two boys alive with severe multiple injuries. The five were found within a 30 m area. The follow-up party arrived at 0030 h and proceeded to evacuate the injured. Two additional victims were found dead at 0300 h, 60 m above the others. At that time most of the follow-up party was withdrawn because the danger of further avalanches loomed and many party members were inexperienced. The remaining searchers continued to probe, and the last two victims were located, dead, shortly before dawn, 12 July. All bodies were removed to Banff and operations were concluded at 1330 h.

AVALANCHE

The avalanche started in wet, loose snow, was about 10 m wide and was caused by radiation from the sun. The party was caught at about 2700 m and carried about 200 m vertically. The snowfield on which they were caught funneled into a rock neck of less steep terrain. A safe rock and snow route existed just to the west of this area.

COMMENT

This tragedy was the result of ignoring basic mountaineering rules. The climbers had little or no mountaineering experience, were poorly dressed, and carried inadequate equipment (one ice axe and one 9 mm rope for a party of 11). Irresponsible leadership was displayed when the men in charge returned to the camp and allowed the eleven boys to continue the climb. The party had neither asked for advice nor registered, although it appeared to be aware of this requirement in a National Park.

Travelling on and below snowfields and snow gullies with southern exposure in the afternoon of a sunny, warm day was a serious mistake. Climbs in such terrain must be made in the early hours of the day, before the snow loses strength and becomes unstable under the influence of the sun.



Figure 1 South face of Mount Temple, showing location of avalanche 11 July 1955 and access route of rescue party. Victims were found at lower end of avalanche. It is not known exactly where the avalanche started or where the party was caught. (Photo courtesy Parks Canada)

One skier killed

WEATHER

Heavy winter snowfall and high winds had been experienced in the Marmot Basin area prior to 11 March. Recent snowfall and high temperatures were increasing the hazard in areas that had not already produced avalanches.

ACCIDENT SUMMARY

A group of skiers left Portal Creek at 0930 h, 11 March, for a day's hiking and skiing at Marmot Basin. The group was informed by a park warden as to which areas in the Basin were considered safe for skiing and which were dangerous and should be avoided. One bowl - later the accident site - was pointed out as particularly dangerous and had been flagged as such.

One couple, after skiing all day in the safe area on the ridge to the right of the bowl, decided to hike for the last run. At 1530 h they were observed to swing left from the trail into the rocky area above and beside the bowl. Leading by about 80 m and moving out onto the avalanche slope, the man shouted back to his companion to wait while he ski tested the slope. He then skied part way down and fell. At this, the snow cracked above him and a large avalanche engulfed him.

RESCUE

The accident was observed from the bottom and a rescue party was immediately organized. After instructing a patroller to bring additional first-aid equipment, the park warden began to climb with a rescue sled kit and shovel. On the way up he met the companion of the victim who indicated the last-seen point.

Upon arrival at the accident site at 1555 h a surface search for clues was initiated and likely areas were probed at random with trail markers which had been collected on the way. The witness was asked to act as a look-out in case other avalanches should occur.

Random probing was continued until 1625 h, when probe lines were set up near the top of the deposition area. The searchers worked in the general fall line from the last-seen point. Reinforcements started to arrive at 1800 h and another probe line was set up adjacent to the previous one, but working up the debris. After probing over a distance of about 60 m, probe contact was made. The rescuers dug down and found first a ski and then the victim buried under approximately 2.5 m of snow at 1935 h.

AVALANCHE

This was a large dry slab avalanche triggered by the weight of the skier and perhaps the cutting effect of his traverse. The small bowl held a concave slope, which was in the lee of the prevailing wind. The maximum depth of fracture was 1 m and the depth of the deposited avalanche snow ranged between 4 and 6 m.

COMMENT

The avalanche occurred in a known danger area about which the victim, an experienced mountaineer, was fully aware. The desire to make a fresh track in powder snow overcame caution with tragic results.

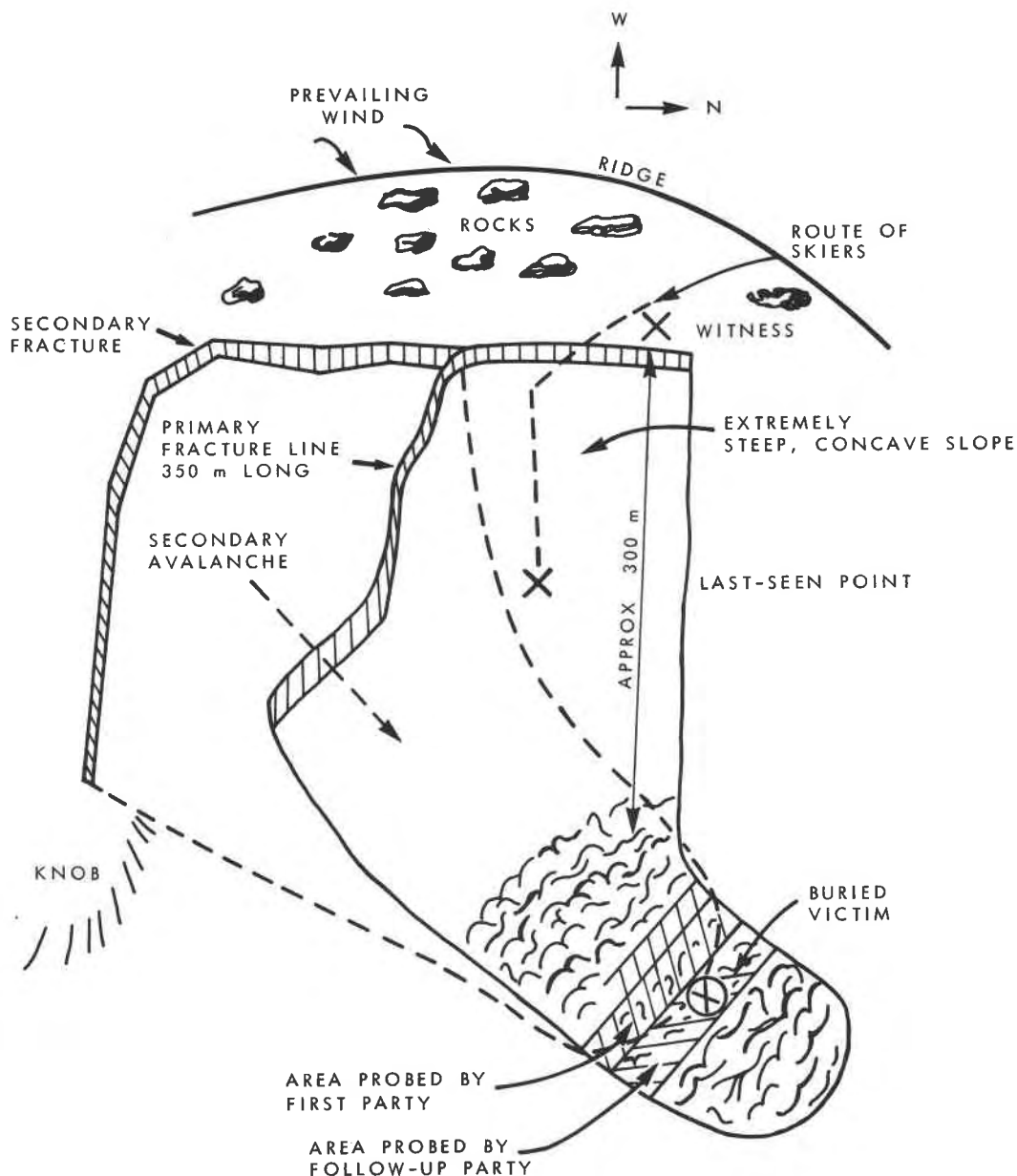


Figure 2 Sketch of avalanche at Marmot Basin, 11 March 1956

One skier killed

WEATHER

Observations at Lake Louise Townsite, 1530 m ASL

Date	Temperature °C	
	Max	Min
13 March	1	-27
14 March	1	-25.5
15 March	3.5	-14.5
16 March	6.5	-19.5
17 March	6	- 5.5

High day temperatures had prevailed for about three weeks. About 80 cm of new snow had fallen in the Temple Lodge area over the previous week.

ACCIDENT SUMMARY

The accident was not observed. A skier, travelling alone, had presumably left Temple Lodge on 17 March. Tracks indicated that he skied up Corral Creek and about 1.5 km from Temple Lodge proceeded to climb an old avalanche path at the end of Richardson Ridge. Presumably he was caught by the avalanche while climbing.

RESCUE

The skier was reported missing to the Park Warden Service at 0945 h on 18 March. At 0955 h an advance search party left Temple Lodge and, following the tracks, arrived at 1030 h at a fresh avalanche deposit where the tracks disappeared. Follow-up parties arrived a short time later and a full search of the avalanche was made. The victim was found buried about 20 m from the toe of the avalanche deposit at approximately 1600 h. The probable cause of death was suffocation.

AVALANCHE DATA

High temperature at the south-facing slope on a sunny, warm day appears to have been the principal cause of the avalanche. It was a large, full-depth avalanche that involved both old and new snow layers. The avalanche path has a south-easterly aspect and is in the lee of the prevailing wind. The starting zone has an incline of about 40 deg and is slightly concave, with a bench below of 20 deg incline. The deposited avalanche snow had components of hard and soft snow and covered an area about 120 m by 120 m.

COMMENT

The skier made the mistake of climbing alone in hazardous terrain. Anyone alone has very little chance of being rescued if buried in an avalanche.

Two skiers killed

WEATHER

A snow cover more than 30 cm deep, deposited in early October, had settled and formed a hard crust. Unusually heavy snowfall followed in November with 30 cm of new snow in the four days prior to the 23rd. Conditions were considered to be windier than usual for that time of year. On 23 November the wind was from the north at 15 km/h and the temperature was -8°C .

ACCIDENT SUMMARY

At 1315 h on 23 November a park warden on ski patrol at Peyto Point parking lot observed an avalanche on the ridge to the north-west of Mount Thompson. He did not see anyone involved, but he and another warden climbed on skis with skins to the site for a further routine check.

RESCUE

At the site the wardens could not observe any tracks, and a hasty search of the avalanche deposit gave no indication of anyone being buried. Two skiers approached, however, and said they thought two friends might have been in the area.

A second hasty search with random probing was carried out and within 5 min a victim was located approximately 1.2 m below the surface. At 1355 h the victim was dug out; he was unconscious and not breathing, and artificial respiration was commenced. At 1400 h the warden in charge sent for further assistance and equipment. A party of 20 volunteers arrived 15 min later and was organized into probe lines. The artificial respiration on the victim was continued until 1500 h with no success.

At 1610 h the body of the second victim was located 1.8 m below the surface. He showed no signs of life and artificial respiration proved of no avail.

AVALANCHE

The avalanche was caused by a combination of new snow, wind, and poor bonding of the new snow on the crust. It was a dry slab avalanche that started at approximately 2430 m ASL. The fracture varied from 75 to 85 cm in depth and the bed surface was the hard crust. The slope has a gradient of 40 deg near the fracture line and a NE aspect.

COMMENT

Skiers frequently use the area at the beginning of the winter because enough snow for skiing can usually be found there before other ski areas open.

The northern edge of the slope was flagged, marking it as an avalanche area. It is not known whether the two victims were beyond the flags or not when the avalanche occurred, for the avalanche was larger than usual and wiped out the flags. Ski tracks with a climbing switch-back traverse and skins on the skis of the victims indicate that they were climbing when the accident occurred. Probably they had entered the slope to find deep snow because winds had bared the rock on the normal ridge route.

Obviously the two skiers had not realized that the snow was in an unstable condition. Their route, a steep slope at the lee side of the ridge, was poorly chosen. The ridge should have been used for climbing and for downhill skiing.

Remarkable is the rapid discovery of the first victim owing to the alertness and initiative of the park wardens. It is unfortunate that in spite of being buried for little more than $\frac{1}{2}$ h the first victim was not found alive.



Figure 3(a) View of avalanche, Bow Summit,
23 November 1958,
(Photo courtesy Parks Canada)

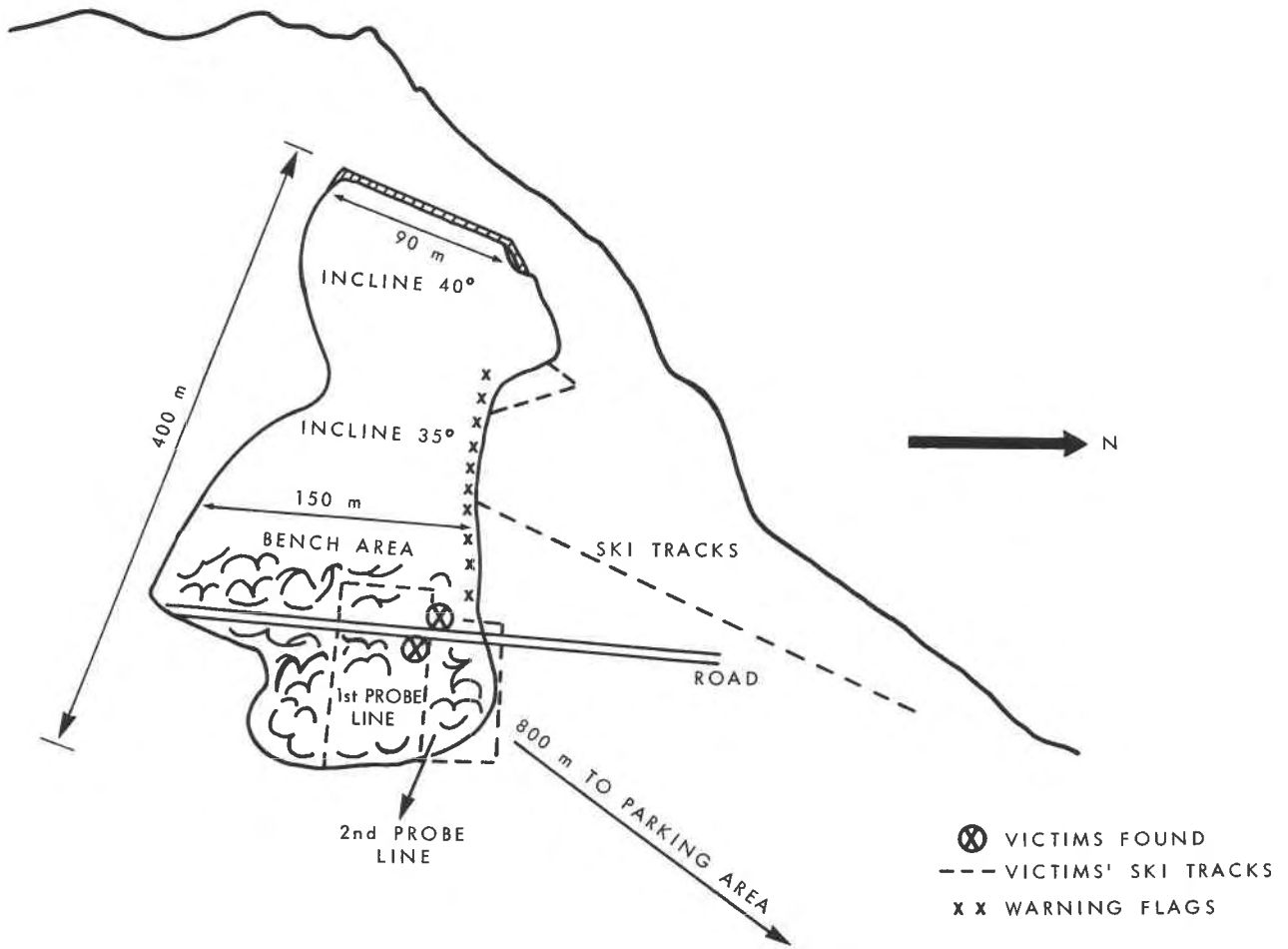


Figure 3(b) Sketch of avalanche, Bow Summit, 23 November 1958

One person buried

WEATHER

Heavy snowfalls were followed by unseasonably high temperatures on Saturday, 30 January, reaching a maximum of 10°C with an overnight minimum of 2°C.

ACCIDENT SUMMARY

A bulldozer was clearing an avalanche on the Toby Creek Road 17 miles northwest of Invermere, B.C., one highway employee acting as flagman and avalanche lookout. Suddenly another avalanche came down from the "Little Dragon Slide." The machine operator saw the avalanche but was unable to warn the flagman. The operator escaped unharmed, but the flagman disappeared in the snow. The time was approximately 1300 h.

RESCUE

The machine operator contacted the RCMP in Invermere and other highway personnel in the area, then commenced a search of the deposits. Within an hour about 40 men were searching at random with shovels. Kootenay National Park search and rescue personnel were called by the RCMP and equipped with probes and shovels. They were joined by a doctor in Invermere. As they proceeded up the Toby Creek Road another avalanche came down between their truck and the doctor's car.

When the National Parks staff arrived some searchers were organized in a probe line near the last-seen point and some were delegated to a random search of the deposits. More probes were requested from Invermere. Once it was thought a shout had been heard near the last-seen point, but the area was searched for over an hour to no avail.

Probing continued until 1930 h when the rescuers were called off because of the hazard from further avalanches in the darkness. Little hope was held of finding the victim alive. At daybreak on 31 January probing was resumed and the whole area had been probed by 1215 h. As the avalanche hazard was again mounting the chance of finding the man alive was weighed against the danger to rescuers from further slides, and it was decided to call the men off.

Two bulldozers began to remove the snow from the road, and it was hoped that the body might be found. After nearly an hour the machine on the west side of the avalanche uncovered a hole from which an arm waved feebly. The flagman was hauled out alive, exhausted and suffering from frostbite. His wet clothes were changed and he was sent to the hospital in Invermere. The time of recovery was 1430 h, 31 January.

AVALANCHE

Heavy snowfall followed by above-freezing temperatures led to the formation of a wet avalanche. The deposit was estimated to be 6 to 12 m deep in places.

COMMENT

At the time the avalanche occurred the flagman was standing near a bank cut in previous snow removal operations. This probably protected him and prevented his being swept from the road, but it also led to an extremely deep burial, deeper than the 3 m probing rods. An air passage from the surface near the old bank assisted in the man's survival. The call heard during the search may well have been the victim's. Another factor favourable to survival was the victim's heavy clothing, which maintained body heat.

During the search the victim's dog was brought in, but he was unsuccessful because he was untrained and confused by the large number of rescuers.

Two climbers injured

WEATHER

About 60 cm of new snow fell in the area of the Columbia Icefields during the two days prior to 23 May. Everyone at the Chalet was strongly advised against skiing or climbing in the area because of a high avalanche hazard. A strong SE wind with freezing temperatures overnight had formed numerous slabs, and sun and above-freezing temperatures on 23 May further increased the hazard.

ACCIDENT SUMMARY

Three climbers, aware of the dangers, decided to attempt to climb Mount Athabasca by the NW face. Deep soft snow made movement very slow and difficult. Unable to climb with skis they left them on the glacier and walked straight up a steep gully on the NW face. The party was approaching an elevation of 2650 m when the leader triggered an avalanche. All three climbers were caught and carried down to about the 2430 m elevation where all were at least partly buried.

RESCUE

One man was able to dig himself out and aid his companions; one had an injured foot, the other a broken femur. The uninjured member then left for help and arrived at the Icefield Chalet at 1300 h, 4 h after the accident. By 1330 h the National Parks Alpine Specialist at the Chalet left, with skis, for the accident site, reaching it at 1530 h. After administering first-aid, he assembled a sled using his own skis and loaded the more badly injured victim on it.

The uninjured party member had been instructed to remain at the Chalet to direct the follow-up column to the site. In spite of this he left and climbed back to the avalanche alone. The assembled follow-up column, therefore, did not know where to go, hesitated, but finally found the tracks and followed them, meeting the returning Alpine Specialist at 1700 h. Together they moved the victims to an ambulance at the road.

AVALANCHE

This was a slab avalanche, started on a west-facing lee slope just above the gully, with a fracture over 100 m wide. The starting zone has an average gradient of approximately 50 deg and steep cliffs. The party was carried down over 200 m vertical distance in a gully.

COMMENT

Recent snowfall and strong wind had obviously formed unstable snow, and under these conditions climbing a steep slope on the lee side of a mountain was extremely hazardous. Protruding rocks in the gully usually increase the risk of injury to anyone caught in an avalanche, and the party was lucky to escape with relatively little harm.

The unauthorized departure of the witness from the Chalet before the follow-up party was assembled could have had serious consequences if the victims had been buried or critically injured.

One climber injured

WEATHER

About 30 cm of new snow had recently fallen on Mount Athabasca with some wind action. On 20 June winds were calm, the sky was overcast and light rain was falling at high temperatures. High avalanche hazard prevailed in the area.

ACCIDENT SUMMARY

Two very experienced climbers decided to climb the summit of Mount Athabasca over the SE ridge on 20 June in spite of being advised of the high avalanche hazard. When they reached about the 2900 m level an avalanche came down from the gully above, pushed them off the ridge, and carried them about 300 m vertically over steep terrain and cliffs.

RESCUE

The accident occurred at approximately 1100 h and was reported at 1700 h. The National Parks Alpine Specialist at the Icefields Chalet left for the scene at 1730 h and found the victims on the lower part of the SE ridge at 1930 h. One victim had sustained an open chest wound and broken ribs, but his companion had rendered first aid and most of the bleeding had stopped. The victim was taken to the road by toboggan and sent by ambulance to hospital in Banff.

AVALANCHE

This avalanche was a slab type, releasing naturally from a gully above the climbers' route.

COMMENT

The accident occurred in the same area and under circumstances similar to those of the accident on 23 May 1960.

One skier killed

WEATHER

On 30 December it was snowing heavily in the Yoho Valley, with low cloud obscuring the peaks.

ACCIDENT SUMMARY

A group of 14 university students had skied to the Twin Falls Chalet in the Yoho Valley on 28 December. They planned to go ski touring in the area while staying at the Chalet, had discussed the avalanche conditions with the park wardens, and were well equipped.

On 30 December the group was scattered along a climbing traverse on the NE slope of Mount Whaleback - four about the 2100 m level, seven around 2000 m, and three in between. At approximately 1200 h an avalanche swept down from the clouds, engulfing the party.

RESCUE

All 14 skiers found themselves at least partly buried when the avalanche came to a stop. After 20 min of digging each other out it was determined that one skier (a woman) was missing. Many of the group were in shock, but the leader managed to organize probing with ski poles and the missing skier was discovered after 30 to 40 min. She was buried under 1 m of packed avalanche snow, unconscious, and not breathing at the time of discovery. Artificial respiration was applied for an hour and a half without success. The victim was later determined to have died of suffocation.

One member of the party left the next morning with word of the accident and park wardens and RCMP officers arrived at the Chalet on New Year's Eve with extra snowshoes to replace equipment lost in the avalanche. On 1 January they departed with the body of the victim. The remainder of the group left the area on 2 January.

AVALANCHE

The avalanche started at approximately 2500 m on a NE slope and caught the skiers at approximately 2100 m. It was probably triggered by overloading from wind-drifted snow. The starting zone has an incline of approximately 35 deg and the lower scree slopes where the party was caught one of about 30 deg.

This was probably a medium size, dry-snow avalanche. In 1972 a very large avalanche on the same slope ran much further and wiped out a bridge at Twin Falls.

COMMENT

The group was evidently climbing the avalanche path at the time of the accident and had not followed basic safety measures, which require that a minimum number of party members should be in the path of an avalanche simultaneously. Such precautions must be adhered to more strictly during hazardous periods such as storms with limited visibility.

One skier buried

WEATHER

Observations at Lake Louise Townsite, 1530 m ASL

Date	Temperature °C		Precipitation
	Max	Min	mm
23 April	5.5	-9	
24 April	9.5	-2	2.5
25 April	13.5	-5	
26 April	16.5	-3.5	
27 April	13.5	-4.5	

On 28 April the weather was warm and calm and several new avalanches were observed in the Temple ski area.

ACCIDENT SUMMARY

As two skiers were traversing the west slope of Larch Ski Hill, the second skier near the top, an avalanche released and caught him. The victim's companion was clear of the avalanche and immediately reported the accident to the Ski Patrol. The time was 1155 h.

RESCUE

An advance party led by a ski patrolman was dispatched at 1205 h and arrived at the site at 1215 h. The witness accompanied this party and indicated the point at which he had last seen the victim. A follow-up party of 45 volunteers was dispatched at 1230 h and arrived at the scene at 1255 h.

A group of park wardens travelling from Banff by car intercepted a radio call concerning the avalanche accident and also proceeded immediately to the site. When they arrived the deposit area had been probed twice, and a third probe and trenching pattern had been started. The warden in charge decided that the witness's report must be incorrect and ordered a search above the last-seen point. When the rescuers worked up the slope and reached scattered small avalanche deposits, they heard a cry for help. Answering and moving in the direction of the cry a warden came upon the victim lightly buried in a treewell with just his

hair showing. The buried skier was 180 m upslope from the last-seen point indicated by the witness. He was freed at 1540 h and transported on a toboggan to the Temple Chalet for further first aid. He was later released with no significant injuries.

AVALANCHE

The avalanche was caused by a loss of strength in the snowcover as a result of continuous high temperatures. It started as a wet full-depth slab at an altitude of 2180 m, just below the treeline on a northeast slope of 25 to 30 deg. The ground was broken shale with small ledges and scattered trees. It had been covered by about 75 cm of snow, which was nearly all removed by the avalanche.

COMMENT

The area where the avalanche occurred was rarely skied, was known as an avalanche slope and posted as such.

The buried victim could hear the rescuers working below him, but only when a rescuer was close to him could he make himself heard. The confusion of the eye witness about the last-seen point could have led to tragedy, but fortunately the victim was not buried deeply and all ended well. The case illustrates the fact that eye witness reports must be assessed with caution.



Figure 4 Temple ski area, 28 April 1963. View of avalanche from the side
o Last-seen point indicated by returning eyewitness
x Missing skier found
(Courtesy Parks Canada)



Figure 5 Temple ski area, 28 April 1963. View from the front. Avalanche snow was 4 to 5 m deep (Courtesy Parks Canada)

Twenty-six workmen killed; twenty workmen injured, buildings destroyed

WEATHER

Observations at Stewart, 45 m ASL

Date	Temperature °C		Precipitation mm
	Max	Min	
11 February	3	-10	15.2
12 February	1.5	- 3	17.8
13 February	1.5	-12	15.2
14 February	2	-10	15.2
15 February	3	- 7	17.8
16 February	2	- 4.5	35.6
17 February	3	- 5	33.0
18 February	2	- 4.5	17.8

In December 1964 the climate stations at Stewart, B.C., Ketchikan, Alaska, and Cape Annette, Alaska, recorded temperatures 5.5 C deg below normal and precipitation 35 per cent below normal. Between 13 and 31 December only 12 mm of precipitation were recorded at Stewart, with overnight temperatures ranging down to -25°C. Both the precipitation and the temperature remained low in the first week of January.

In February heavy snowfalls followed the early cold dry weather. For several days prior to 18 February a great sub-arctic storm raged and an estimated 4.3 m of snow fell at the Granduc Mine.

ACCIDENT SUMMARY

The Granduc Mine is 30 km northwest of Stewart, B.C., near the Alaska border; the Leduc Camp of the mine was located on a moraine at the junction of the North and South Forks of the Leduc Glacier and was accessible only over glacier covered terrain.

At 0957 h on 18 February an avalanche destroyed the southern portion of the camp and the buildings surrounding the mine portal, not quite blocking the portal. In the camp proper there were four bunkhouses, a

recreation hall, warehouse, first-aid building and temporary hospital, a small helicopter hangar with workshop, and ten smaller buildings. After the avalanche only the bunkhouses, mine office, warehouse, the first-aid building/hospital were left intact. Between the camp and the portal, and at the portal itself, there were a large power-house, a large workshop and new and old dry buildings. All were demolished.

There were 154 men in the Leduc Camp ; 68 of them were caught in the avalanche. The others were in buildings that were untouched or were working in safe areas outside; 21 men were working underground. The men caught in the avalanche were shovelling roofs, bulldozing pathways, digging out equipment and working on construction and machinery in the area of the mine portal. One of them was Einar Myllyla who was alone in the carpentry shop.

RESCUE

The avalanche destroyed the power-plant, but within minutes auxiliary power was connected to the radio transmitter and a distress signal was sent to the Stewart mine office. Survivors, fortunately including a doctor and a first-aid attendant, commenced rescue operations immediately. At the time of the disaster 15 men were working outside the portal and all were buried. The mine shift boss, who had fortunately been on the surface just before, knew the approximate positions of all these men and set the underground crew working in the hope of uncovering survivors. All 15 were found fairly quickly; six were alive, but nine were dead on recovery.

As most survivors in the rest of the camp were in varying states of shock and injury, the rescue work was slow. Lack of proper equipment and the ongoing storm hampered operations. Using bare hands, shovels and makeshift equipment, 41 men were saved that day, the last one to come out alive 5 1/2 h after the slide.

The distress signal to Stewart was heard by the Alaska State Police who immediately notified the RCMP in Prince Rupert. Mine officials in Stewart had operations well under way, arranging for a helicopter base to be set up and ground rescue to be initiated. As normal air access to the mine from Stewart was still impossible, a helicopter base was set up at the mouth of the Chikamin River on the Alaska side. Meanwhile ground rescue teams had left by snowcat from the nearest road camp; although it would take three days to cover the rugged 55 km, this might be the only means of rescue if the area remained closed by air.

The news was almost immediately in the hands of the press and brought aid from many quarters of British Columbia and Alaska. By 1700 h operations at the camp had become more organized: communications with Chikamin were established and a helicopter pad was bulldozed out of the debris in front of the wrecked mess hall. Unknown to all, Einar Myllyla lay 3 m below the pad in an icy prison, conscious of operations above him.

On 19 February the first helicopter was able to reach the camp from the Chikamin River base, after spending the night on a glacier between the two sites, forced down by weather. Further machines brought additional trained rescue personnel and trained rescue dogs. An evacuation shuttle to Chikamin and Ketchikan was established.

The search for survivors was greatly hampered by the mass of wreckage in the snow. Rescue dogs were confused by the maze of human scents. Probing turned up only more scattered material. Poor visibility, snow, fog, and wind continually hampered operations. For two days, between fitful comas, Myllyla could hear helicopters landing and taking off above him. Finally, on 21 February, after abandoning hope of finding further survivors, careful trenching of the debris began with bulldozers shearing off only a few inches at a time. Spotters rode the blade to watch for bodies.

On that afternoon, while work progressed in the area of the helicopter pad, a large section of snow sheared away, revealing a blinking Myllyla, who looked up at astonished spotters saying "Don't move me, I think my legs are frozen." He had been buried for 3 days, 6 h. He was immediately taken to Ketchikan where a team of doctors saved all but the toes of one foot and some fingers. The last body was recovered by mine personnel on 18 June - leaving 26 dead and 20 injured.

AVALANCHE

The details concerning this avalanche are rather sketchy. Montgomery Atwater, the expert flown in at the time of the disaster, described the starting zone on Granduc Mountain after the avalanche occurrence as having "hardly enough snow to cover the brush." His analysis of the situation was as follows:

"Abnormally low temperatures in early winter were accompanied by high winds which may have created unstable hard slab conditions. In February exceptionally heavy storms deposited large quantities of snow on the unstable base, until it finally collapsed yielding a large climax avalanche falling some 2500 vertical feet onto the camp."

The prevailing winds in the area are usually west or southwest, scouring the slopes at Granduc Mountain. In this case an east wind may have loaded the starting zone with deep snow.

COMMENT

The Granduc disaster is the largest of its type to have occurred in Canada since the Rogers Pass disaster of 1910. The rescue operation, involving so many diversified international groups, can only be praised as a massive effort on the part of many. Adverse weather conditions and geographic factors of terrain and location made all operations most difficult.

Winter observations of Granduc Mountain had not been made prior to the winter of 1965 and no previous avalanche occurrences had been observed that winter. The camp was located on a moraine forming a promontory, with the adjacent depression providing a natural, probably unplanned, avalanche catcher. As the camp grew it proliferated down from the moraine, exposing more and more buildings. Furthermore, the mine portal was in the track of large avalanches. Avalanche control was not applied here prior to the disaster, but a large-scale program was later introduced for the protection of the camps and access road. During the rescue operation helicopter bombing at Granduc Mountain was carried out by M. Atwater, probably the first time this control method was used.

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- 2) Province of British Columbia. Annual Report of the Minister of Mines and Petroleum Resources for 1965, Victoria, B.C.

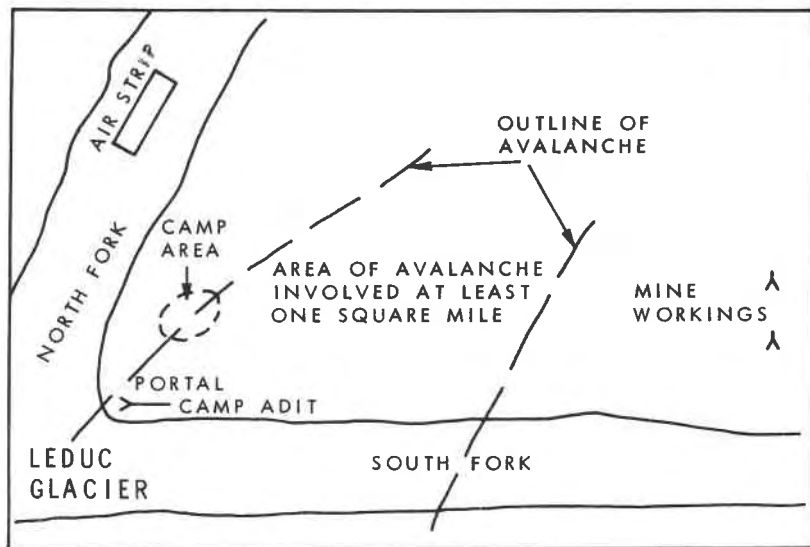


Figure 6 Plan of Leduc Camp, Granduc Mine (not to scale).
 (British Columbia Department of Mines and
 Petroleum Resources, Annual Report, 1965)

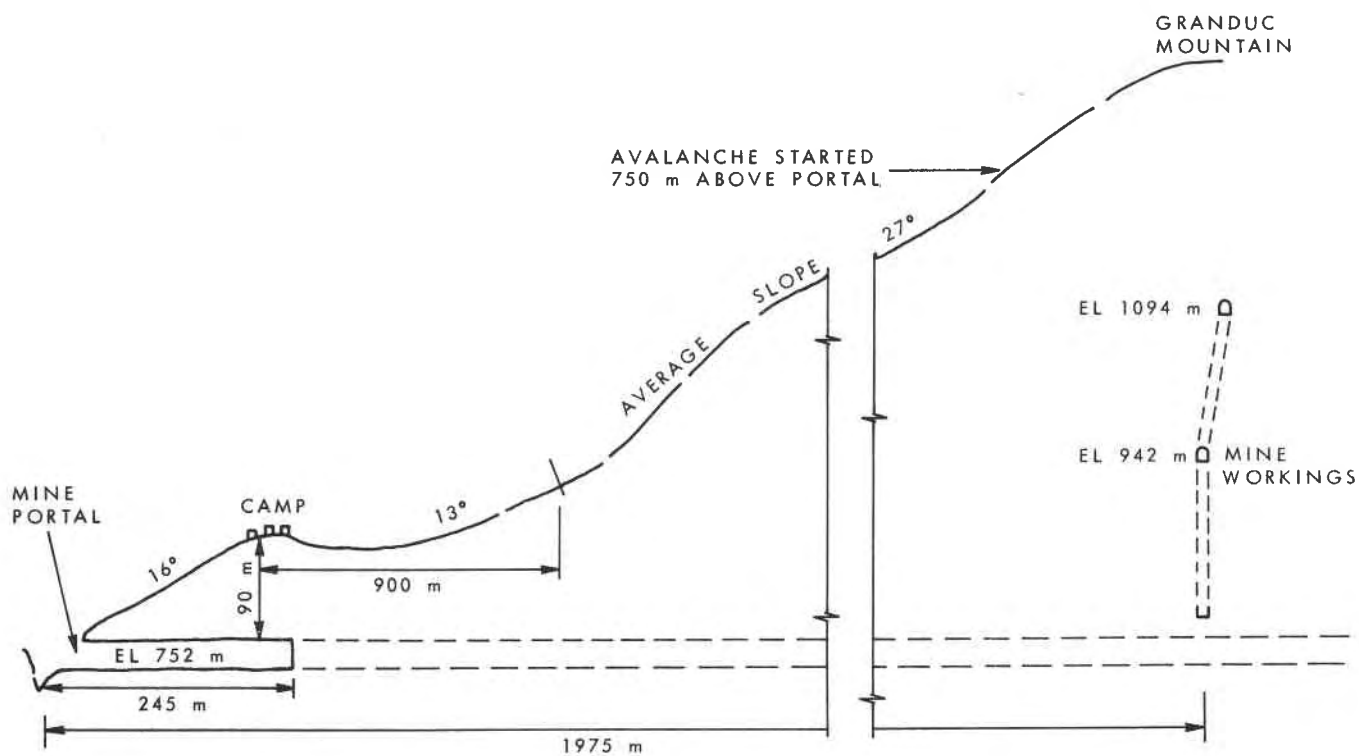


Figure 7 Avalanche profile, Granduc Mine (not to scale).
 (British Columbia Department of Mines and
 Petroleum Resources, Annual Report, 1965)

One skier killed

WEATHER

Observations at Banff Townsite, 1655 m ASL

Date	Temperature °C		New Snow	Precipitation
	Max	Min	cm	mm
24 February	0.5	-10		
25 February	6.1	- 3.5	T	
26 February	3.5	- 4.5	6.8	6.6
27 February	-4	-13	21.1	17.0
28 February	-5.5	-18.5	1.3	0.8

The mean maximum temperature at Banff townsite for December 1964 was -10.4°C , the minimum -19.5°C . These temperatures fall considerably below the 1949-70 means: maximum -8.5°C , minimum -13.0°C . Total precipitation in December 1964 and in January 1965 was considerably below the 1949-70 mean.

ACCIDENT SUMMARY

Two skiers, both experts, were skiing from the Mt. Norquay chairlift into a gully north of the Lone Pine Run. The leader triggered an avalanche and his companion saw him disappear in the moving snow. The time was 1230 h.

RESCUE

The witness climbed back to the patrol hut at the top of Mt. Norquay where he reported the accident at 1235 h. Rescue operations were immediately started.

A two-man search party arrived at the site at 1250 h. The leader, a park warden, assessed the debris, determined the most likely location of burial and directed the 16-man follow-up party to the bottom end of the avalanche where probing was started in three lines. Guards were posted and an escape route was planned owing to the extreme avalanche hazard.

At 1430 h the victim was located approximately 100 m from the toe of the avalanche, buried under 2 m of snow. As soon as his head was

uncovered mouth-to-mouth resuscitation was started and continued while his body was uncovered. The victim was transported by toboggan to a first-aid station 400 m away where a doctor continued artificial respiration until 1550 h with no positive results. The victim was determined to have died by suffocation.

AVALANCHE DATA

New snow on a weak base of depth hoar was the cause of this dry slab avalanche, with a fracture 450 m wide. It released at an altitude of approximately 2100 m on a 35 deg slope with an easterly aspect. The moving snow was channelled and the avalanche deposit varied in depth from 3 to 6 m.

COMMENT

The slope where the avalanche occurred was outside the ski run, was posted as an avalanche area, and known as such to local skiers. It had been neither skied before nor stabilized by other means. It would appear that the victim could not resist the temptation of skiing the new snow on the undisturbed slope, and that by doing so he triggered the avalanche.



Figure 8 Avalanche, Mount Norquay, 28 February 1965
a) Deposition zone and track of avalanche
b) Fracture and bed surface of avalanche
(Courtesy Parks Canada)

One car buried and one person killed

WEATHER

Observations at Kootenay Pass Summit, 1770 m ASL

Date	Temperature °C		New Snow cm
	Max	Min	
24 December	-4.5	-11	30.5
25 December	-5	-18.5	40.5
26 December	-6	-12.5	5
27 December	-3.5	-11	24
28 December	-3.5	- 5.5	56

Heavy snowfall at the Kootenay Pass on 24 December and on the morning of 25 December tapered off into light intermittent snowfall with cooler temperatures on the 26th. Heavy snowfall resumed on 27 December and continued throughout the day, causing several avalanches that reached the road and required short closures for clean-up.

ACCIDENT SUMMARY

About 0430 h, 28 December, the Kootenay Pass highway foreman was notified by a snowplow operator that an avalanche was blocking the highway 4.3 km east of the summit at elevation 1500 m. The foreman proceeded immediately to the scene and found that several small dry avalanches had combined to cover the highway to a depth of about 2 m. Walking over the deposited snow from the west side the foreman noted a light coming from a hole in the snow and on closer investigation discovered a sedan car. The car was covered by about 50 cm of avalanche snow; a man was inside, slumped over the wheel.

RESCUE

A member of the highways crew entered the car via the hole in the snow and the open passenger window to attempt to rouse the driver. He was unable to do so; no signs of life were evident and rigor mortis had started to set in. The fan of the car heater was blowing, the ignition switch turned on, but the engine was not running. The time was about 0445 h.

The RCMP and a doctor were immediately called to the scene, while highways personnel conducted a search for a possible car passenger.

Although it seemed probable that the driver had opened the passenger window and pushed a hole up through the snow, a companion could have done this and made his escape. The snow on the road was probed, but no further victims were found. The occupant of the car was officially pronounced dead and removed from the scene at 0800 h. Carbon-monoxide poisoning was later determined as the cause of death.

AVALANCHE

Several avalanches had started from different locations on a large open rock bluff 450 m above the road. The starting zone had an approximate gradient of 40 to 45 deg, with a south-east aspect. The avalanches covered about 200 m of the highway with an average depth of 2 m. The avalanche deposit was loose and dry and did not damage the automobile.

COMMENT

The truck-plow had left the summit on an easterly run at about 0300 h, and did not meet any traffic. From the amount of new snow on the avalanche deposit it was probable that the avalanches had run shortly after the plow had passed. The victim, also travelling east, must have been caught shortly after 0300 h. He was unhurt, apparently decided to wait for help, and kept the engine running in order to keep warm.

The car was equipped with hot coffee, food, and blankets, indicating preparedness for winter driving. Although an airhole had been punched through the avalanche snow, it was insufficient to allow the heavy exhaust gases to escape, and the victim was overcome by carbon monoxide. It may be concluded that a most important measure when one is in a car and buried in snow is to turn off the engine immediately.

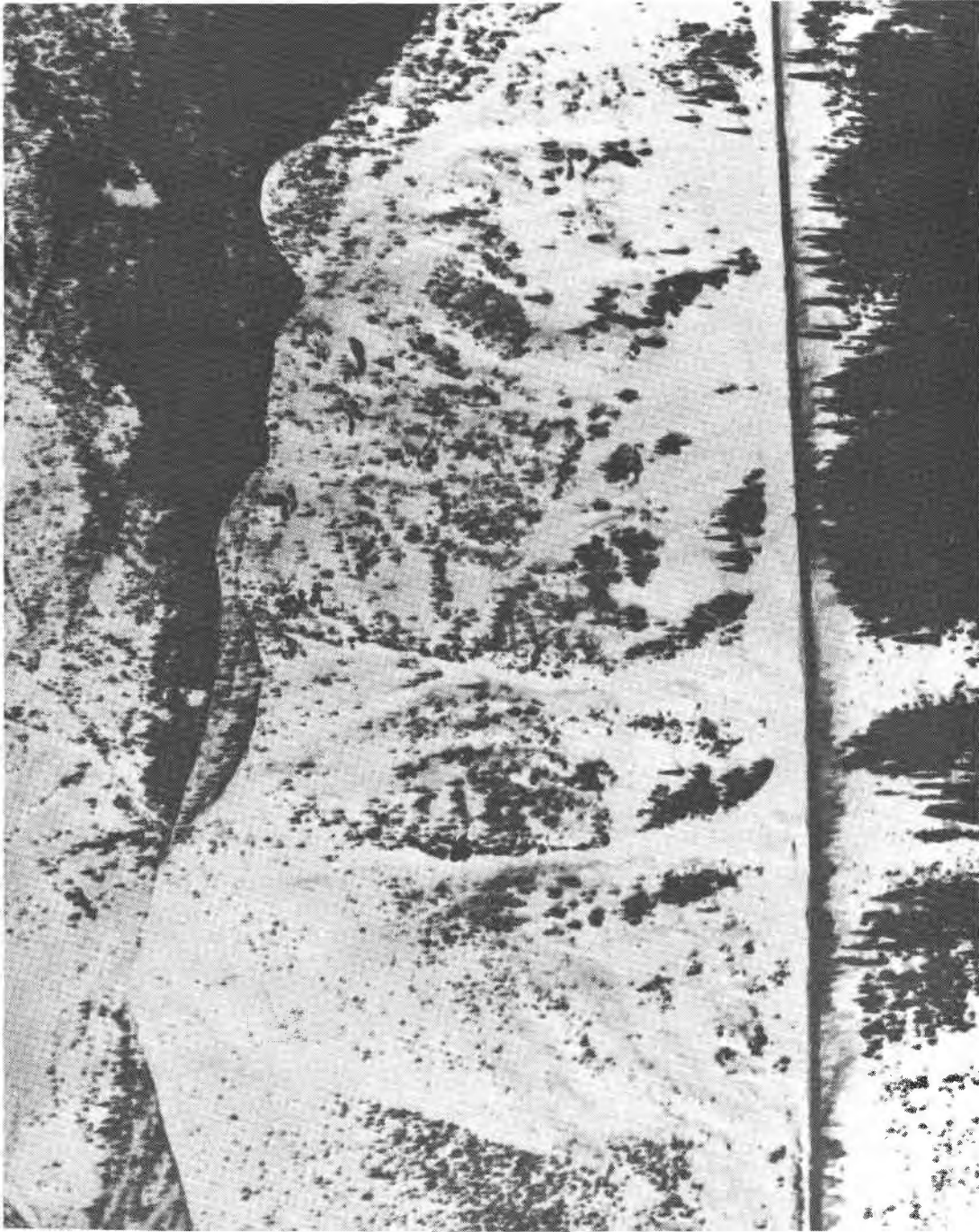


Figure 9 View of avalanche area east of Kootenay Pass
(Photo courtesy British Columbia Ministry of Highways and Public Works)

Two workmen on road killed

WEATHER

Observations at Rogers Pass, 1307 m ASL

Date	Time	Temperature °C		New Snow Depth cm	Water Equivalent mm	Total Snow Depth cm	Wind	
		Max	Min				Direction	Speed km/h
4 Jan	0700	-21.5	-22			130	NW	24
	1630	-20	-22	2	2	131	NW	16
5 Jan	0700	-19.5	-21	2	3	130	NW	5
	1630	-18	-20.5	1	1	133	NW	19
6 Jan	0700	-12	-19.5	16	12	146	N	6.5
	1630	-6	-12	31	14	174		
7 Jan	0700	-3	-6	11	10	174	SE	3
	1630	-1	-3.5	13	10	178	SE	8
8 Jan	0700	-1	-3	4	3	172	S	3
	1630	0	-3.5	8	10	170	S	24

Recorded Average hourly Wind on 8 January at MacDonald, West Shoulder,
1930 m ASL

Time	Direction	Speed km/h
0100	S	16
0200	S	6.5
0300	W	1.5
0400	SW	8
0500	S	1.5
0600	SW	8
0700	S	21
0800	S	120
0900	S	120
1000	S	96
1100	S	120

Note:

The maximum capacity of the recorder is 120 km/h. It was estimated that the windspeed exceeded this level by a considerable amount on the morning of 8 January.

Between 27 December and 8 January 166 cm of new snow fell in the Rogers Pass area at low temperatures. These unusually low temperatures caused the snowpack to remain loose and unsettled.

The MacDonald West Shoulder area was stabilized by artillery on 2 January, 6 January, and again at 2000 h, 7 January. During the last shoot an avalanche was observed to come half way down the alluvial fan of path No. 4. Rumbling was heard as a result of a round fired into path No. 3, but no avalanche was observed owing to limited visibility.

At 0800 h on 8 January the windspeed changed from between 8 and 24 km/h to speeds in excess of 120 km/h. An unprecedented accumulation of wind-transported snow in the avalanche starting zones and increasing temperatures caused the hazard to rise quickly. The Trans-Canada Highway was closed at the gates of the National Park at 0850 h.

ACCIDENT SUMMARY

At 0900 h a natural avalanche occurred at MacDonald West Shoulder, path No. 4, followed at 0910 h by an avalanche in path No. 3. Each covered the highway for a length greater than 100 m. The avalanche hazard analyst considered that traffic travelling inside the park gates would not have had time to clear the area, and that someone could have been caught in the avalanches, particularly in path No. 3. Because the unstable snow had been removed from the starting zones of paths No. 3 and 4 the area below was reasonably safe, and a probing party was organized and dispatched to path No. 3 at 0920 h. All personnel were warned of the extreme hazard from the adjacent paths No. 1 and 2, as well as from the Cheops path No. 2 across the valley. An avalanche look-out was posted.

A front-end loader and a D-6 bulldozer began to remove the deposited snow from path No. 3. The operators were made aware of the extreme danger from further slides, but they continued to work. At 1053 h a release was observed in the basin above path No. 2 and a warning call given. The probe team immediately ran to safety, but the machine operators could not react so quickly and were caught when the avalanche hit the road and lapped over the avalanche deposit in path No. 3.

RESCUE

The probe team on site started an immediate search for the operators. The loader had been carried to the edge of the road and turned over, one wheel just showing above the snow; the bulldozer was completely buried. After about 2½ h the loader operator was recovered, dead. The body was removed and the search continued for the other operator.

Snow and high winds continued and by 1450 h regeneration in the release areas created such a hazard that the rescue teams were withdrawn. Because the avalanche blocked access to the firing positions, the gun had to be dragged across the deposits. Stabilization by artillery was, therefore, a slow and dangerous process. By 1825 h gunfire had been used, and

the area was considered safe enough to allow rescue operations to be resumed. The tractor operator's body was recovered at 1945 h. His machine was still upright, but was 30 m off the road.

With the ongoing storm the hazard remained extreme and operations were closed down for the night. Shooting began the following morning and the highway was opened in the evening.

AVALANCHE

Unconsolidated deep snow, extremely strong wind, and a rising temperature were the factors that caused the dry slab avalanche, which started at an elevation of 2700 m and ran to the highway at 1310 m. The snow in paths No. 1 and 2 fractured simultaneously over a total width of 450 m and a depth of between 1 and 5 m. The avalanche covered 300 m of the highway and 20 m of the previously deposited snow in path No. 3. Trees 50 to 60 years old between paths No. 2 and 3 were torn out.

Records of avalanche occurrences at Rogers Pass since 1953 do not list an avalanche of similar size at this site, although smaller avalanches have reached the highway on the average of once in two years.

The avalanche control staff on the spot estimated $1\frac{1}{2}$ min as the time between the start of the avalanche and its arrival at the highway. This would correspond to an average speed of 100 km/h. The average incline of the avalanche track is 31 deg.

COMMENTS

The accident is a reminder of the hazard of further avalanches, particularly in adjacent paths, when an avalanche has covered a road. The possibility of additional avalanches must always be considered before snow removal operations are carried out. Additional avalanches can endanger not only the maintenance staff but also traffic that is sometimes stopped in front of avalanche deposits.

One skier killed, one injured

WEATHER

Observations at Lake Louise Townsite, 1530 m ASL

Date	Temperature °C		Snowfall cm	Total Snow Depth cm
	Max	Min		
26 Jan	-5.5	-20.5		96.5
27 Jan	-3	- 9.5	7.5	101.5
28 Jan	1	- 8.5	10	109
29 Jan	1.5	-12.2	T	106.5
30 Jan	1	-10	10	117

The avalanche hazard was considered to be high owing to wind, which had produced a slab condition above the treeline, and to high temperatures in the afternoon.

ACCIDENT SUMMARY

A group of three skiers, a mountain guide, a ski patrolman, and another local resident, left the top of Eagle Chair to ski the powder snow at the Ptarmigan Ridge. The group traversed a slope marked with signs 'Avalanche Area' by following the tracks of many others who had defied the warning.

The lead skier tested a short steep slope with no results, then all three continued the traverse into the area of the Ptarmigan Chutes, passing old tracks made during the previous weekend. The second chute was chosen for downhill skiing.

The patrolman led off, skied about 50 m downslope, then stopped. The guide passed him and continued down another 100 m. The third skier then started down and the patrolman recommenced his run, stopping again by some small trees where he turned to see an avalanche coming down the chute. The third skier shouted a warning, but both the patrolman and the guide were caught by the fast-moving snow. The patrolman grabbed a tree, but it broke under the impact of the avalanche and he was carried further down with the snow. He saw his companion being flipped into the air beside him. A second wave of snow engulfed the patrolman, but he was

able to stay on top by swimming and was free when the slide came to rest, suffering only an injured shoulder. The third skier had escaped the avalanche, but the guide was nowhere to be seen. The time of the accident was 1435 h.

RESCUE

Another skier who happened to be near the accident site immediately skied out for help. He shouted to those on the chairlift, and they in turn alerted the ski patrol at 1440 h. The patrol immediately contacted the park warden in the area and organized a search party. The first rescue group arrived on the site at 1500 h, marked the last-seen point, and set up probe lines. Some were directed to search other likely burial spots, and when additional equipment arrived from Temple Lodge, the probe lines were extended.

The guide was discovered at 1520 h lying face down under 1 m of snow at the base of a large tree by one of the probers who searched likely burial spots. By 1525 h he was freed from the snow and cardiopulmonary resuscitation was commenced by a doctor in the rescue group. CPR was continued until 1605 h when the doctor declared that the victim would not recover.

AVALANCHE

The avalanche was caused by recent snowfall and wind. Avalanches had been released by explosives in this area earlier in the winter. It was a dry slab avalanche with a high-speed flowing motion and a powder component. Its path has a southeast aspect in the lee of the prevailing wind, the top of the slope a cliff that is usually overhung by cornices. The avalanche fractured at the slope transition below the cliff where the inclination is about 40 deg. The avalanche deposit was 250 m long and 60 m wide, with a maximum depth of 3.5 m.

COMMENT

It is hard to understand why experienced mountaineers, who knew the avalanche paths of the area and had had an opportunity to observe continuously the weather and the snow conditions would ignore the avalanche hazard. The desire to ski steep, undisturbed slopes sometimes appears to be stronger than the thought of danger.

One car buried

WEATHER

Heavy snowfall on 15 March tapered off and continued to be light through 16 March. Strong, gusty wind prevailed throughout the night of 15 March and the night of the 16th.

ACCIDENT SUMMARY

Late in the evening of 16 March two truck-plows were working on the east side of Kootenay Pass towards the summit. One car travelled between them, and two light trucks followed. Without warning an avalanche came from the rock bluffs above the road, catching all five vehicles. The two truck-plows were partly buried, one with only the cab flasher showing. The two vehicles following were lightly buried and their drivers were able to get out, but the automobile between the plows had disappeared.

RESCUE

Because the car had been travelling between the plows it was quickly located. Digging down through about 2 m of loose snow the truck operators found the rear car window open and the driver conscious and unhurt. The driver informed them that he was all right and would wait in the car until it was removed from the debris.

The plow drivers then proceeded to the summit and reported to the foreman who decided the driver should not have been allowed to stay with his car. Rushing back to the accident site, the plow operators dug down to find the driver unconscious at the wheel. One man went through the open rear window with a rope and the unconscious driver was hauled to the surface. All symptoms indicated that the man was suffering from CO poisoning, but he was still breathing weakly. A doctor in Creston, who was contacted by radio, instructed the crew to exercise the limbs of the victim, and he was slowly worked into consciousness, then placed on a toboggan, hauled about 1 km over other avalanche deposits and brought by ambulance to Creston where he recovered completely.

AVALANCHE

The avalanche, caused by snowfall and wind, occurred on the east side of Kootenay Pass where numerous avalanches often cover the highway over a length of about 1 km. On 16 March 1967 about one dozen avalanches reached the highway in that area and deposited snow up to 4.5 m deep on the inside lane.

COMMENT

The accident occurred at the same location and under circumstances similar to those of the accident on 28 December 1965 (see Figure 9). The driver, buried in the snow, ran his car engine for a short time to gain a bit of warmth but was soon overcome by carbon monoxide. He was lucky to be saved by the quick action of the highway foreman.

One skier killed

WEATHER

New snow totalling about 30 cm fell in the area in the first week of December. On 9 December the wind was southwest, the temperature -4.5°C , and wind slabs had formed.

ACCIDENT SUMMARY

On 9 December a party of four young skiers departed from the youth hostel to hike and ski on Parker Ridge. While returning to the hostel the party came across a small steep bowl facing northeast. The lead skier traversed the slope from right to left. When a second skier followed his track, a slab broke above, she fell, and the slab slid over her. The time was approximately 1500 h.

RESCUE

The victim was located by her companions at 1530 h, unconscious and not breathing, buried under 30 cm of snow in a sitting position. Artificial respiration was carried out for over an hour with no response. A park warden, called by a member of the group, arrived on the site with a toboggan at 1720 h and took the body to the highway for transportation to Banff. Suffocation was later determined as the cause of death.

AVALANCHE

Southwesterly wind from the Saskatchewan Glacier was responsible for the formation of the avalanche. The windward, northeast side of the ridge above the avalanche site was blown bare of snow and deep snow had accumulated on the lee side. The avalanche was a dry slab that fractured with a depth of 30 to 100 cm and barely broke up during its short run. The inclination of the slope where the avalanche started is 35 deg and that of the surrounding terrain 20 to 25 deg.

COMMENT

The accident is an example of the hazard to skiers from even small avalanches. As this case demonstrates, the snow may fracture not when the first skier crosses the slope but with the second or later skiers.

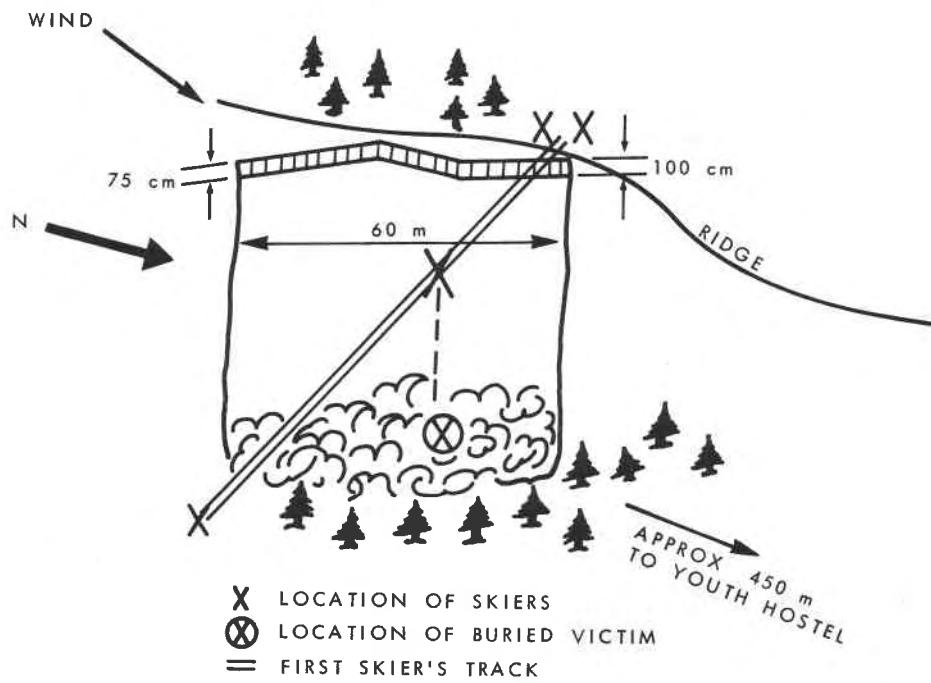


Figure 10 Sketch of avalanche, Parker Ridge, 9 December 1967

One skier killed

WEATHER

Observations at Bow Summit, 2050 m ASL

Date	Temperature °C	New Snow cm
18 March pm	6.5	2
19 March am	0	
19 March pm	3.5	2
20 March am	-4.5	
20 March pm	6.5	
21 March am	-6.5	2
21 March pm	3.5	
22 March am	0	1
22 March pm	2	
23 March am	-1.5	
23 March pm	6.5	

On 23 March at the accident site the temperature was approximately 4°C and winds were calm

ACCIDENT SUMMARY

A party of one man and two women left the Banff-Jasper highway at Hector Creek to climb Mount Hector on skis. When they met two other skiers on the way up, the five proceeded together to the foot of the Hector Glacier. The initial party of three, inexperienced mountaineers, decided to stop there while the other two, experienced mountaineers, continued. The experienced skiers advised the others to wait for their return before descending to the highway.

Disregarding the advice, the three decided to return to the valley, but on the way they deviated from their climbing route and entered an adjacent bowl. Here the man in the party skied below a cornice at the top of the slope, starting a large avalanche that swept him down. The time was approximately 1430 h.

RESCUE

The two women were standing in a rocky area adjacent to the fracture line when the avalanche released, and they observed the man being carried away. They were afraid, however, to go down the slope to investigate.

After completing their run on the glacier and not finding the other three, the two experienced skiers followed the tracks until they found the two women. One of the men descended the slope and located a ski sticking out from under some large blocks of deposition part way down the avalanche path. Buried beneath about 1 m of snow, the victim was unconscious and not breathing. The skier attempted artificial respiration, but did not observe any sign of recovery.

One of the group reported the accident to the park wardens at 1700 h, and a helicopter, using searchlights, flew to the site at approximately 2000 h and picked up the body.

AVALANCHE DATA

Unstable depth hoar had been observed all winter in the area and together with drifting snow may have caused the formation of the avalanche, which was triggered by the skier.

This was a dry slab avalanche, which released about 2740 m ASL on a slope with a northeast aspect and incline of about 35 deg. The prevailing wind in the area is southwest.

COMMENT

If the two parties had not split up the accident would probably not have happened. Owing to inexperience the victim chose a dangerous slope on his downhill run, and because of the inexperience of his two companions he was recovered too late. An immediate search by the two witnesses might have saved the life of the skier.

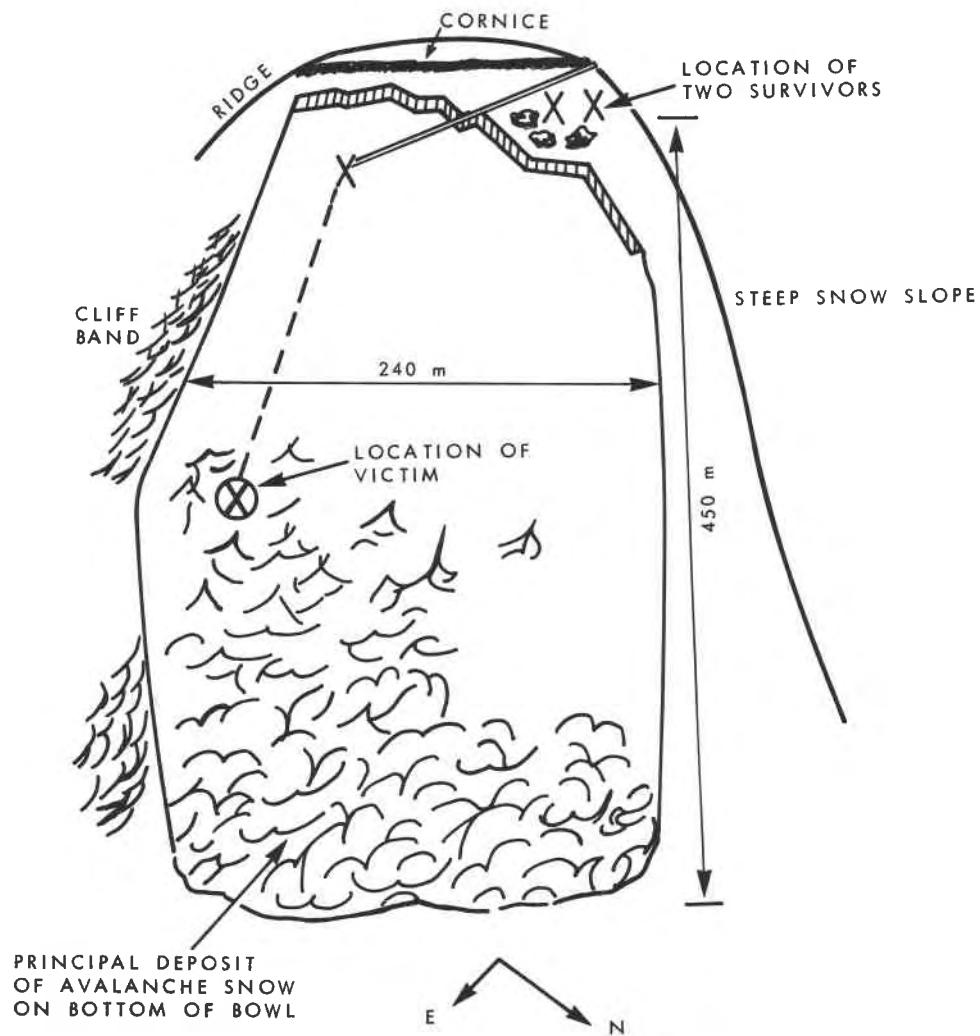


Figure 11 Sketch map of avalanche at Mount Hector, 23 March 1969

One skier buried

WEATHER

Observations at Whitehorn Study Plot, 1720 m ASL

Date	Temperature °C		New Snow cm	Snow Depth cm
	Max	Min		
20 Jan am	-6	- 9.5	3	51
pm	0	- 8	T	50
21 Jan am	-1.5	-11	T	49
pm	-3.5	-10	T	49
22 Jan am	-4	- 5.5	4	53
pm	0	- 5		51
23 Jan am	-2	- 6	4	55
pm	0	- 5.5	T	53
24 Jan am	0	-13		53
pm	-4.5	-12.5		53

Winds were calm and the sky cloudy in the Deception Pass area on 24 January.

ACCIDENT SUMMARY

Two skiers left Temple Lodge to ski to Skoki Lodge via Boulder and Deception Passes. Both had some ski mountaineering experience and were equipped for an overnight tour. At 1600 h, while they were traversing a steep side hill southwest of Deception Pass, an avalanche released and caught both of them.

RESCUE

When the avalanche came to rest one skier was able to free himself, but he could not locate his companion. He therefore skied back to report the accident at Temple Lodge at 1715 h. The first search party organized by National Park wardens left at 1730 h, arriving at the site at 1800 h. Probing was organized immediately, and the victim was located at 1830 h buried under 1.2 m of snow. He was lying on his side, unconscious.

Artificial respiration was administered and the victim began to recover. Suffering from extreme shock and oxygen deficiency he was removed by motorized toboggan and transported to the hospital in Banff where he recovered completely and was released that evening.

AVALANCHE

The avalanche occurred at approximately 2300 m ASL on a south-facing slope. This was a full-depth avalanche, fracturing through a depth of 1 to 2 m. The deposition was coarse and chunky.

COMMENT

The two skiers were traversing a dangerous slope and could have picked a safer route lower down the slope. As is often the case, choosing a slightly slower, less direct route in safe terrain would have been a wise move. The victim survived for an unusually long period. Statistics of avalanche accidents show that chance of survival after being buried for 2 h are only 10 per cent.

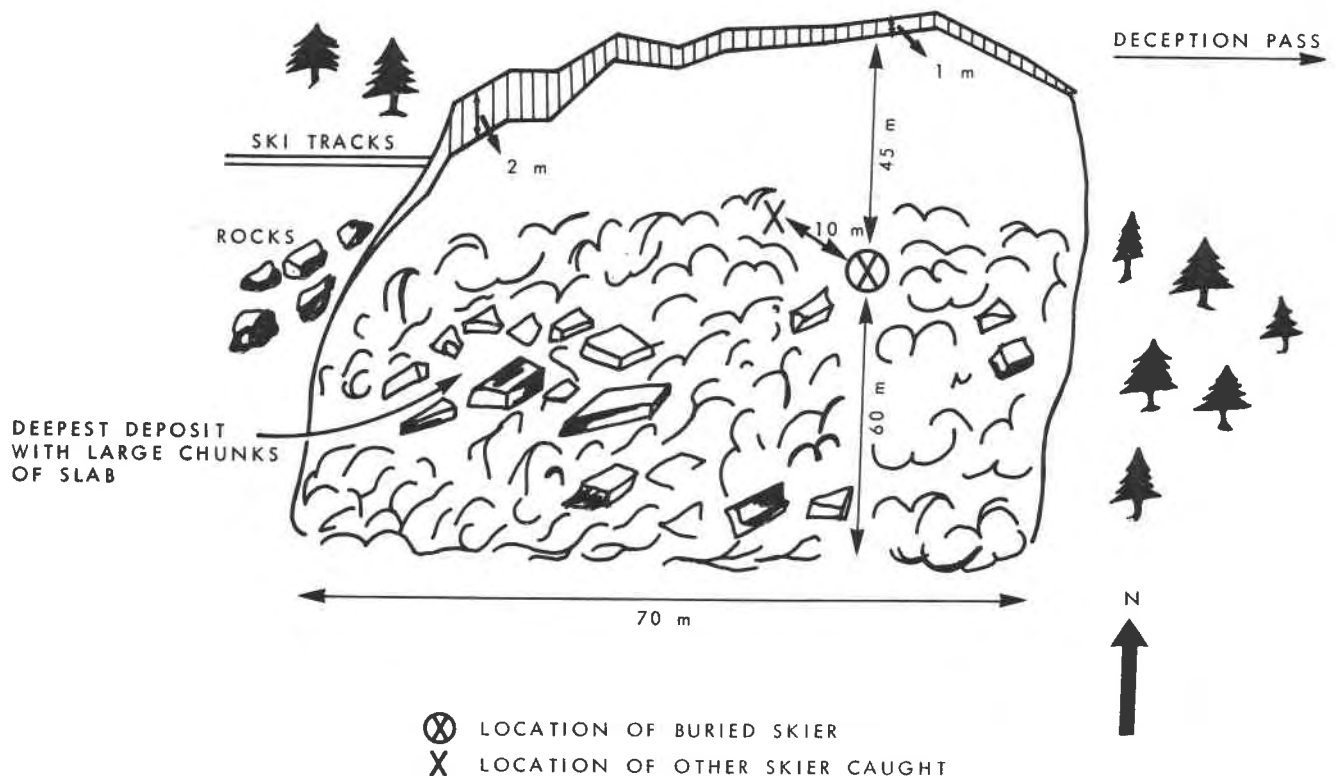


Figure 12 Sketch of avalanche at Deception Pass, 24 January 1970

One skier killed

WEATHER

On 10 January approximately 1 m of snow had accumulated at the Westcastle Ski Area. Temperatures during the latter part of December were very low, ranging down to -30°C . The ski patrol noted that depth hoar had formed. On 21 January a temperature inversion was experienced, with temperatures of -23°C recorded at the base and -2°C at the top of the lifts 520 m higher. At approximately 0930 h the ski patrol narrowly escaped three medium-size natural avalanches on the upper mountain. Because of the high hazard the lifts were closed, but no explosive control was carried out. High wind conditions developed that afternoon.

The day of the accident, 24 January, was a clear day with temperature just below freezing and some good powder skiing on lee slopes.

ACCIDENT SUMMARY

On 24 January a group of three skiers from Calgary came to Westcastle searching for fresh powder snow. The party was observed skiing down lift lines and was advised by the ski patrol to ski on the main runs only and not in the trees because the snowpack was insufficient to cover stumps and roots.

At approximately 1500 h the three skiers entered the top of an area known as Shotgun Gulch and began to ski down together in the powder snow. Suddenly an avalanche released above them. Two of the skiers were near the sides of the gulch and able to ski clear of the avalanche, but the third was swept down by the fast moving snow.

RESCUE

When the avalanche stopped it was evident that the third skier was buried in the avalanche deposit. One of the witnesses skied down for help while the other began a surface search for clues to the victim's location. Approximately 10 min after the accident, the ski patrol was notified and a rescue immediately organized. Probes that were stored at the top of the lift were picked up and shovels were collected in the base area. The operator at the top of the lift was instructed by radio to gather all patrolmen riding the lift. Twenty-five minutes after the accident a rescue party left the upper lift terminal.

Upon arriving at the scene rescuers found that the witness on the site had located a ski pole and glove about one third of the way down

the deposited snow and a toque about two thirds of the way down. A probe line was set up near the toque and probing began uphill. A second team probing at the toe of the deposit located the victim approximately 15 m uphill from the toe of the avalanche deposit, approximately 1 m below the surface. The time was not established. It was immediately evident that the victim had sustained severe multiple injuries and was exhibiting no signs of life. Doctors at the site declared the victim dead, and later examination indicated that the cause of death was severe head injuries.

AVALANCHE DATA

The dry slab avalanche fractured over a width of 15 m and a depth of 2.5 m on a base of depth hoar. The trigger was probably the combined weight of the three skiers. The avalanche ran a distance of approximately 400 m and the deposition was chunky and hard in texture.

COMMENT

An avalanche warning sign had been placed on a tree at the top of Shotgun Gulch in 1968. It was checked in 1969, but no check was made at the beginning of the 1969-70 season. On 25 January the sign was missing. After the accident the area was roped off and has been opened and closed intermittently since then.

Control with explosives, carried out at the proper time, could have prevented this accident.

ACKNOWLEDGEMENT

The information on this accident was collected by R. Wilson-Smith.

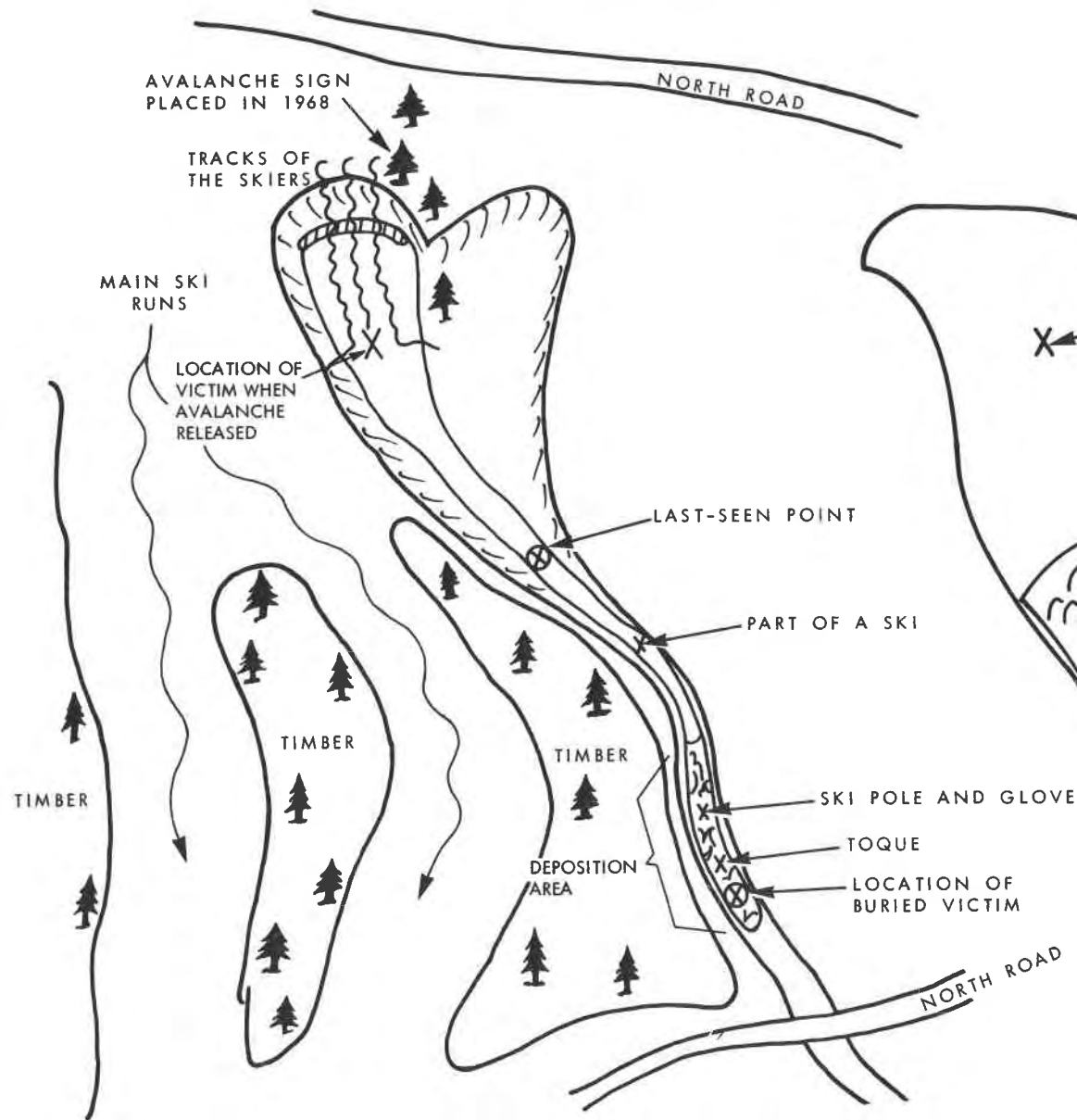


Figure 13 Sketch of Shotgun Gulch, Westcastle, Alberta, 24 January 1970

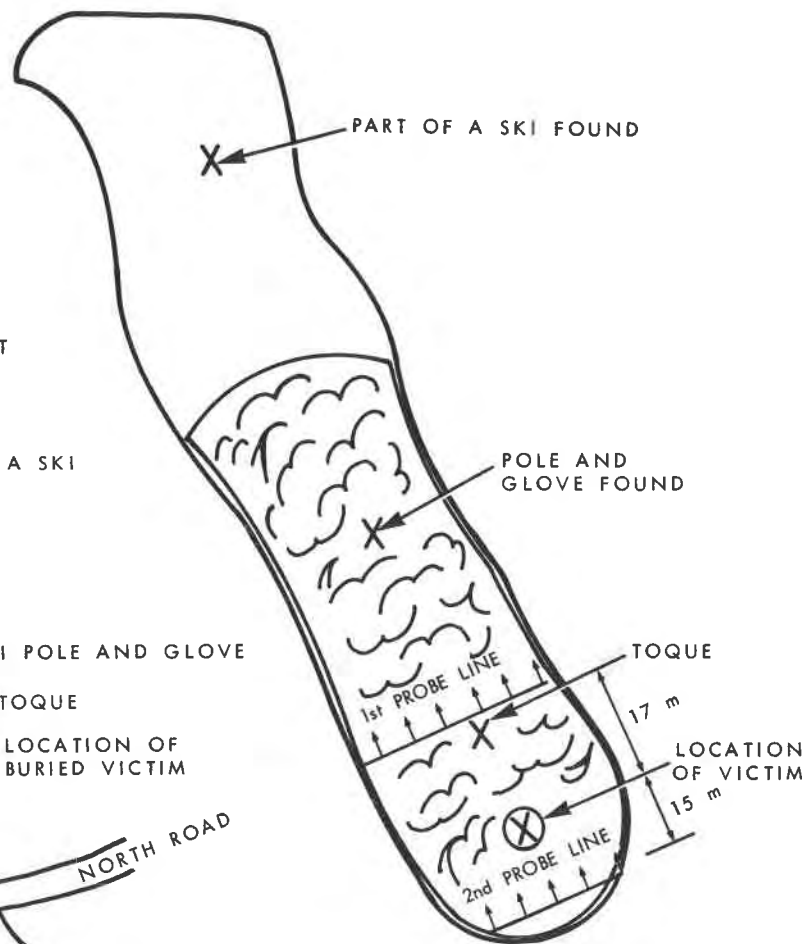


Figure 14 Avalanche deposition area, 24 January 1970

Tank farm damaged and oil spilled

WEATHER

High temperatures were observed from 3 June to the early hours of 7 June. Wind velocities increased to 100 km/h, with gusts to 140 km/h in the early hours of 6 June. In addition, on 6 June the wind direction changed to north-northeast, almost parallel to the gully in question.

ACCIDENT

The tank farm is located on Deception Bay (at the northern tip of Ungava, west of Sugluk) about 5 km from a camp operated by the owners of the tank farm. At the time of the accident the entire bay was covered with ice.

As the tank farm is not visible from the camp, there were no eye witnesses of the avalanche. The tank farm was last seen intact on 5 June. Inuit people passing it on 8 June found it destroyed and reported the fact to the camp. The avalanche had struck the tanks on a broad front and run out on the sea ice. Four of six tanks were destroyed and one damaged, causing a spill of 427,000 gallons of arctic diesel oil and gasoline.

Damage to the tank farm, replacement cost, loss of oil and gasoline was estimated at \$523,000. Details of the damage caused by the oil have been reported (Ramseier et al., 1973).

AVALANCHE

The avalanche was a slush flow caused by rapid melting and failure of the water-saturated snowpack. High air temperatures in association with strong winds were responsible for the rapid rate of snow melting. The average depth of the avalanche fracture was 3 m. It had a flow depth of about 8 m in the gully and deposited snow 2 m deep at the oil tanks.

The starting zone was at an altitude of 145 m and the tank farm at 20 m. The profile shows an inclination of the avalanche track between 6 and 17 deg.

COMMENT

Slush avalanches are common in the Arctic but have also been observed in alpine areas. They are usually caused by rapid melting, which produces more water than can be drained at the bottom of the snowpack. At Deception Bay the meltwater produced by high air temperature probably accumulated on a frozen stream in the gully.

Remarkable is the gentle terrain that spawned this avalanche. It shows clearly that slush avalanches can occur on terrain far less severe in slope than that recorded for other types of avalanche. A gully channelled the moving slush, producing high speed and great destructive force. The possibility of slush avalanches must be considered in the selection of sites for structures in the Arctic.

REFERENCE

Ramseier, R.O., G.S. Gantcheff, and L. Colby, 1973. Oil Spill at Deception Bay, Hudson Strait. Environment Canada, Inland Water Directorate, Water Resources Branch, Ottawa, Scientific Series No. 29.

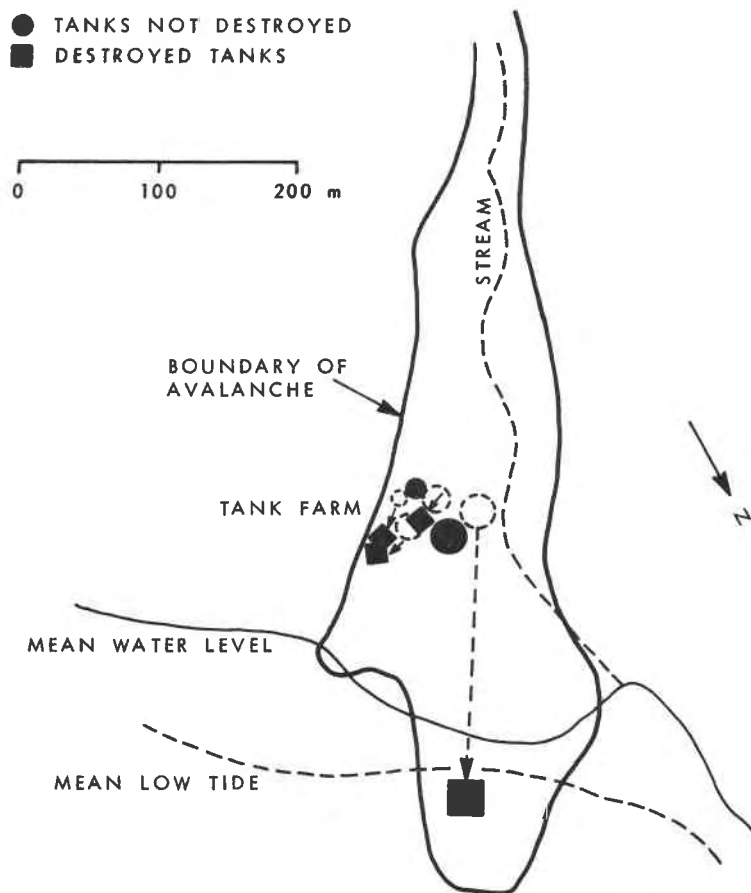


Figure 15 Sketch of avalanche, Deception Bay, Ungava Peninsula, Quebec, 6-7 June 1970. (Ramseier et al, 1973)

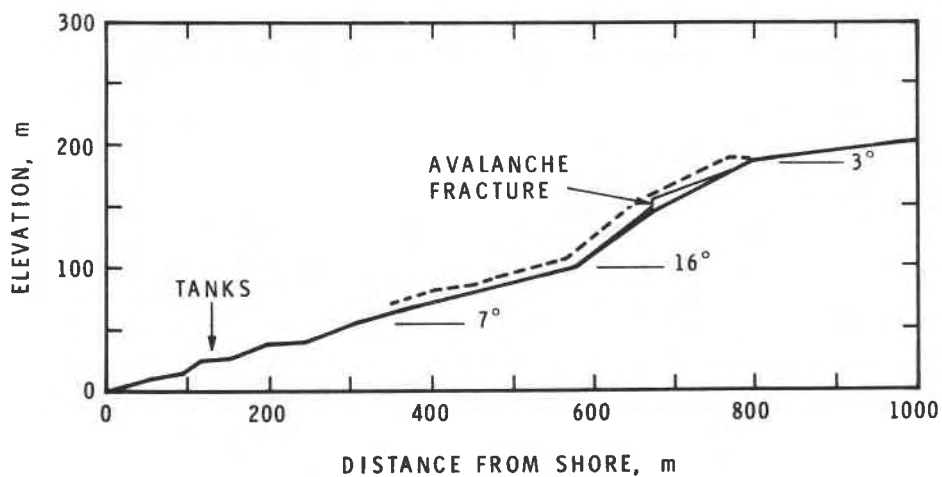


Figure 16 Profile of avalanche track, Deception Bay, 6-7 June 1970

Mine powerhouse damaged

WEATHER

Observations at the Mine Site, 1670 m ASL

Date	Temperature °C		New Snow cm
	Max	Min	
1 Dec	- 8	- 9.5	18.3
2 Dec	- 7	- 9.5	11.7
3 Dec	- 7	-10.5	11.7
4 Dec	-12	-14	4.1
5 Dec	- 4.5	-19	27.4
6 Dec	- 1	-14	46.2
7 Dec	- 0.5	- 5.5	19.3

ACCIDENT SUMMARY

Several avalanche paths surround the mining camp (see also 16 January 1974). On 7 December an avalanche ran from the Ruth Slide area southeast of the mine and struck the mine powerhouse, destroying the walls and roof and damaging machinery.

AVALANCHE DATA

This was a natural soft-slab avalanche that released at an altitude of 2000 m and fell 430 m to the powerhouse. The avalanche path has an average slope of 42 deg and a north aspect. The powerhouse was located in the run-out zone of the avalanche at the toe of the slope.

COMMENT

The mine could not be operated for six weeks following the avalanche. Avalanches occur frequently in this area every winter, but they are not usually large enough to damage the buildings. More severe damage was caused on 16 January 1974.



Figure 17 Ruth-Vermont Mine, showing Ruth (left) and Sheba (right) avalanche paths; the powerhouse is the uppermost building. An avalanche-catching barrier was later built.

One skier killed

WEATHER

Observations at Rossland-MacLean Station, 1082 m ASL

Date	Temperature °C		Precipitation mm
	Max	Min	
19 Dec	-5.5	-9.5	2.5
20 Dec	-2	-6.5	10.2
21 Dec	-0.5	-6.5	10.2
22 Dec	2	-2	12.7
23 Dec	0	-3	6.6

About 30 cm of new snow fell on Granite Mountain in the 24 h prior to 1300 h, 23 December, and a warming trend was noted from the early morning hours to mid-afternoon. Overcast conditions and intermittent snow prevailed throughout the afternoon.

ACCIDENT SUMMARY

At about 1315 h on 23 December a group of five experienced powder skiers entered the Squaw Basin of Granite Mountain. Numerous chutes and glades fall from Buffalo Ridge through Squaw Basin into a traverse that leads back to the regular ski runs.

The skiers entered an open, slab-like slope near the top of Squaw Basin and proceeded to ski down. As the last skier started his first turn, the slope fractured around him and a small fast-flowing avalanche carried him down. The rest of the party were near a treed area lower down the slope and saw their companion caught by the moving snow, but they were unable to locate him when the avalanche stopped. It had moved through a sparsely treed area, had piled up snow at several locations, and stopped below the witnesses. One skier immediately departed for the base lodge to report the accident to the ski patrol. The time was about 1345 h.

RESCUE

The three remaining skiers divided the deposition area into sections and proceeded to comb it for clues. One member climbed to check the

slope above, but it was presumed that the victim had been carried with the main mass of snow through the trees to the slope below.

Meanwhile, the messenger reached the ski patrol at the bottom of Granite Mountain at about 1400 h. Volunteers were enlisted and a search party equipped with probes and shovels was dispatched immediately, arriving at the scene of the accident at 1440 h. Two probe lines were established, one on the higher open slope and one on the lower slope, with a few individuals assigned to a random search of the treed areas.

At 1510 h the victim's lower arm was discovered protruding from the snow at the base of a tree about 30 m below where he had been caught. Digging down, the patrolmen discovered the victim bent unnaturally backwards against the tree and lightly buried. He was immediately removed from the snow, cardiopulmonary resuscitation was administered, but no signs of life returned. The body was removed by toboggan and arrived at the base patrol room at 1610 h.

The cause of death was determined to be suffocation, but spinal injuries had been sustained in the slide. Witnesses thought that the man would have been able to raise himself from the avalanche snow if he had been conscious when he came to rest against the tree.

AVALANCHE

The avalanche was a soft slab, dry and unconfined, with a depth of fracture of about 80 cm in recent snow layers. The starting zone is about 1900 m above sea level, faces north, has a ground surface of smooth granite slab and a slope gradient of about 35 deg. The avalanche deposit was of fairly uniform consistency and had piled up around trees to a maximum depth of 1.4 m.

COMMENT

The avalanche was probably triggered by the skier, who was the last of the five down the slope. It is often believed that a slope is stable if the first one or two skiers pass safely, but as the example illustrates this is an incorrect and dangerous assumption. Many times, especially with deep slab instability, only the combined weight of several persons may initiate an avalanche or the failure process may be delayed.

The case illustrates that avalanche victims are sometimes found in snow that has stopped at trees in the avalanche path (see also 28 April 1963). Trees, therefore, are likely spots of burial and must be checked during the first, hasty search.

The accident took place away from the regular ski runs, in a known and marked avalanche area although the slopes are always heavily tracked following fresh snowfalls. Such hazards exist in many ski developments and education of the skiing public is probably the best way to prevent accidents.

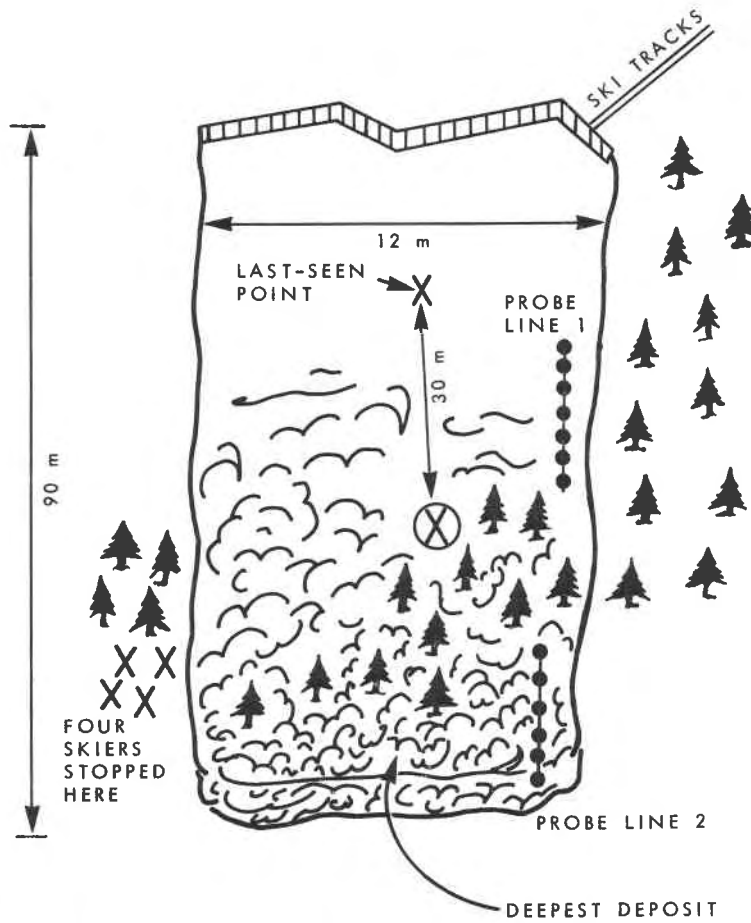


Figure 18 Sketch of avalanche site, Granite Mountain, Rossland, B.C., 23 December 1971

Three people on road killed

WEATHER

Observations at Fernie, 1030 m ASL

Date	Temperature °C		Precipitation mm
	Max	Min	
20 Dec	-1	- 5.5	30.2
21 Dec	1.5	-10	10.2
22 Dec	-9.5	-14.5	26.5
23 Dec	1.5	-18	10.9
24 Dec	3	-14.5	18.8

The snowfall at Fernie is generally greater than that in the Flathead Valley. On 24 December it was snowing in the Flathead Valley, with wind from the southwest. Observations made after the accident revealed that the snowcover in the area consisted of 20 cm of depth hoar, 80 cm of old hard snow, and 60 cm of new snow on the surface.

ACCIDENT SUMMARY

The accident was not observed. The victims, employees of a logging company, were coming out from a bush camp in the Flathead Valley for the Christmas holiday.

It is assumed that the men were making their way along the forestry road in a pick-up truck and small tractor when they encountered avalanche deposits on the road; that they investigated the deposit on foot, and that a second avalanche must have struck and swept them from the road. When the men had not reported by Christmas Day, a party was sent to investigate. Behind a large avalanche deposit it discovered the truck and bulldozer, both with ignition switches "on", although the vehicles had run out of fuel. It was concluded that the men were probably buried in one of the avalanches and search operations under the direction of the RCMP were initiated.

RESCUE

A number of large avalanches had crossed the road and fanned out into the valley and across the river, leaving an extensive area to be

searched. The searchers assumed that the victims had been swept from the road, carried down the 20 m embankment and buried on the flats below, although no clues could be found.

The first victim's body was recovered 29 December at 1430 h, using a bulldozer, and systematically digging through the debris. On 3 January the other two bodies were located, one using a bulldozer and one by an RCMP search dog which had arrived that day. All three men were buried under approximately 2 m of snow and had died from suffocation.

AVALANCHE

The avalanche started at an altitude of 1850 m and ran over 650 m vertically on a 23 deg gradient. The avalanche track in question is about 80 m wide. Details of the type of avalanche are vague. It seems to have been a dry slab type that fractured through the old snow layers on an eastern exposure. The debris, deposited to a depth of 3 m, was quite hard by the time the accident was discovered.

COMMENT

The accident is an example of the danger of walking over avalanche deposits during hazardous periods. The close position of the bodies would indicate that the men were in a group and caught by surprise by a fast-moving large avalanche.

The search dog was not brought to the site until 11 days after the avalanche occurred. As in many other cases, the dog proved to be the superior search method, for after only a short time he found the dead body lying in water under 2 m of hard snow.



Figure 19 Avalanche, Flathead Valley. View from valley bottom.
(Photo courtesy D. Marino)

Two tobogganers killed

WEATHER

Observations at Toronto Highland Creek Station

Date	Temperature °C		Precipitation mm
	Max	Min	
1 Feb	-1	-13	
2 Feb	0.5	- 6.5	7.6
3 Feb	1.5	- 3	2.2
4 Feb	-4.5	- 8	2.5
5 Feb	-7	-14	T

On the afternoon of 5 February it was snowing, with winds blowing from the northwest at 10 km/h and temperature -12°C .

ACCIDENT SUMMARY

Highland Creek forms a ravine about 25 m in depth near the intersection of Markham Road and Highway 401 in Scarborough, adjacent to a residential area. Wind-drifted snow had formed a cornice on the north edge of the ravine.

At 1530 h on 5 February two young girls, residents of the area, left their homes to find a suitable place for tobogganing. It appears that they were walking along the north edge of the ravine when the cornice collapsed beneath their weight. The children dropped about 8 m and were buried by the falling snow at the steep side of the ravine.

RESCUE

When the two girls did not return home for dinner the police were alerted. A search was instituted that grew to very large proportions, with hundreds of volunteers. Foul play was first suspected and an avalanche would naturally not be a search consideration in Metropolitan Toronto. At 1730 h on 6 February, however, one searcher noted a fresh slide on the north side of Highland Creek ravine near the residential area. Digging down he found the body of one girl under 1 m of snow and about 15 m from the top of the ravine; shortly afterwards the other body was discovered 1.5 m uphill under 0.5 m of snow.

AVALANCHE DATA

The cornice had formed at an altitude of 170 m ASL, above a ravine 25 m deep with an average slope of 45 deg. About a 2 m length of cornice broke off and the snow deposition was a maximum of 2 m deep. Whether or not any slab release was associated with the cornice failure is unknown, but the debris was described as being "snow as big as huge stones."

COMMENT

This case, together with the Cap Santé case of 14 January 1976, illustrates the fact that hazardous avalanches may occur not only in high mountains but anywhere that terrain and snow form the right combination.

Three mountain climbers killed, one injured

WEATHER

Observations at Marmot Basin, 2067 m ASL

Date	Temperature °C		New Snow cm	Snow Depth cm	Wind km/h
	Max	Min			
15 Feb	-6	-14	2	129	25
16 Feb	-6.5	- 9	13	142	80
17 Feb	-3	-13.5	T	140	30
18 Feb	-3	-15.5	1	137	13
19 Feb	-9	-10.5	1	136	30
20 Feb	0	- 8.5	9	143	25

The mean temperatures recorded at Marmot Basin in December 1971 were a maximum of -12.6°C and a minimum of -21.3°C , with a total snowfall of 78 cm. In January the mean maximum temperature was -13.2°C and the mean minimum -23.3°C , with a total snowfall of 110 cm. The cold weather produced an unconsolidated snowpack (see Figure 20).

ACCIDENT SUMMARY

A climbing party of four, all experienced climbers, registered at 0800 h on 19 February to ascend the East Ridge of Mount Edith Cavell, planning to return on the 20th around noon. The party left the junction of Highway 93A and the Edith Cavell Road about 0830 h, arriving at the Tea House about 1115 h by means of motor toboggans.

The group then climbed a snow headwall to the saddle at the bottom of the East Ridge, and proceeded up the snow-filled gully to the left of the standard East Ridge route. Some time after 1700 h, near the top of the gully, they decided to dig a snow cave and bivouac for the night. The snow cave was almost finished when a crack was heard and the roof fell in. The time was about 1830 h.

RESCUE

Climber No. 1, who had been in the cave at the time of the start of the avalanche, was swept down, and after sliding and free falling came to

rest on the saddle at the bottom of the gully. Although he was partly buried and had a broken arm, he was able to free himself and began a search for his companions. One lay near by, his right side buried. Climber No. 1 was able to dig away the snow and found that his companion's right leg was severely injured. Climber No. 1 wrapped the injured man in any loose clothing and sleeping bags he could find on the surface and continued his search for the other two party members. Finding only scattered equipment and unable to locate the others, climber No. 1 left to seek help at approximately 2000 h.

Carrying a torch, a ski pole and a pot of honey, he made his way down the headwall. After travelling on foot all night and through the morning of 20 February, he reached his car and drove about 7 km to the Cavell Warden Station, arriving about 1200 h.

Rescue was initiated immediately. A group of park wardens, an RCMP officer and equipment were gathered at the junction of 93A and Edith Cavell Roads at 1315 h. One group was dispatched on foot while the others awaited the arrival of a helicopter. At 1430 h two wardens were air-lifted to the saddle. The injured climber and an assortment of equipment were located almost immediately, lightly covered by new snow. The climber, however, was dead by that time. Blizzard conditions and poor visibility prevailed.

At about 1600 h the weather cleared enough for a dog and handler and three more men to be flown in. The body of climber No. 2 was flown to Jasper and all personal belongings were cleared from the avalanche to allow the dog to begin his search at about 1620 h. The dog located the third climber's body at 1630 h, buried under 10 cm of hard avalanche snow and 10 cm of new snow. The dog then located various personal objects and the last body at approximately 1745 h. The third victim was buried fairly deeply, however, his hand extended toward the surface and covered by about 10 cm of hard snow and 10 cm new. Evacuation of the victims and the search party began at approximately 1815 h and was completed at 2030 h.

AVALANCHE DATA

The avalanche probably fractured over the full depth of the snow on weak layers formed during the cold weather in December and January. Deep drifting snow had probably accumulated in the gully. It started at an elevation of approximately 2800 m and was probably triggered by the climbers when they excavated the snow cave. The gully faces south-east and has an average gradient of 40 deg. The deposited avalanche snow was up to 5 m deep, hard, and scattered with rock chips.

COMMENT

Snow-filled gullies must be travelled with caution during the winter because they are natural channels for avalanches; furthermore, the deep snow in them may hide weak layers, and its stability can change rapidly

with the onset of wind, fresh snowfall, or high temperatures. For these reasons a gully appears to be the wrong place for a night's bivouac.

The case demonstrates how long it may take an organized rescue party to reach the site of an avalanche accident in the back country. In such cases a rescue alive is usually possible only by the efforts of survivors. It is sad that two of the victims at Mount Edith Cavell were buried too deep and that the avalanche was too large to permit a successful search by one person.

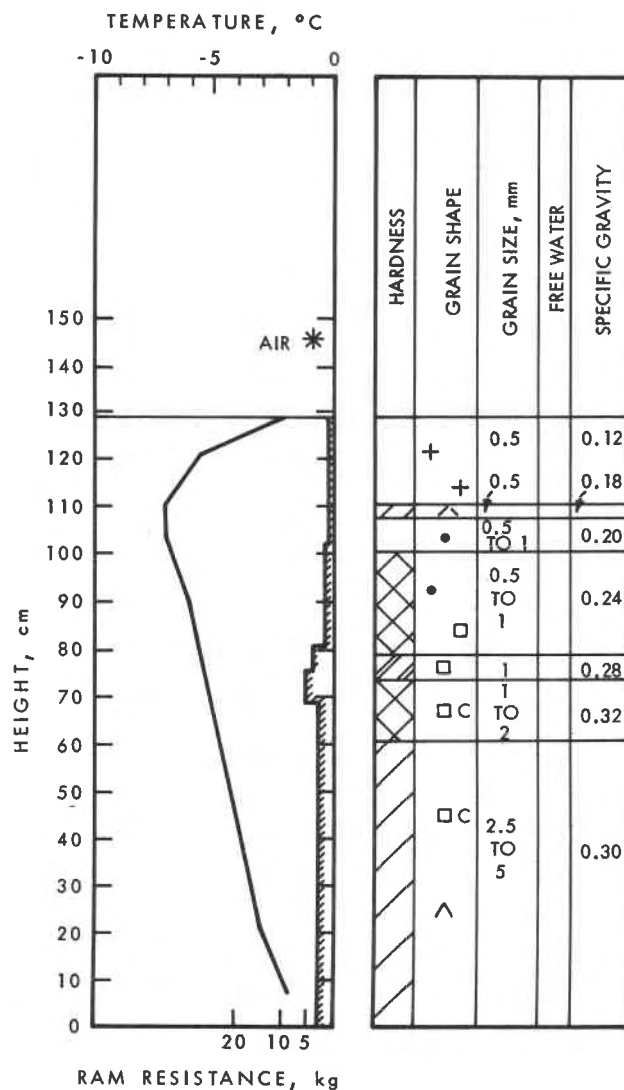


Figure 20 Snow profile at Marmot Basin, 19 February 1972

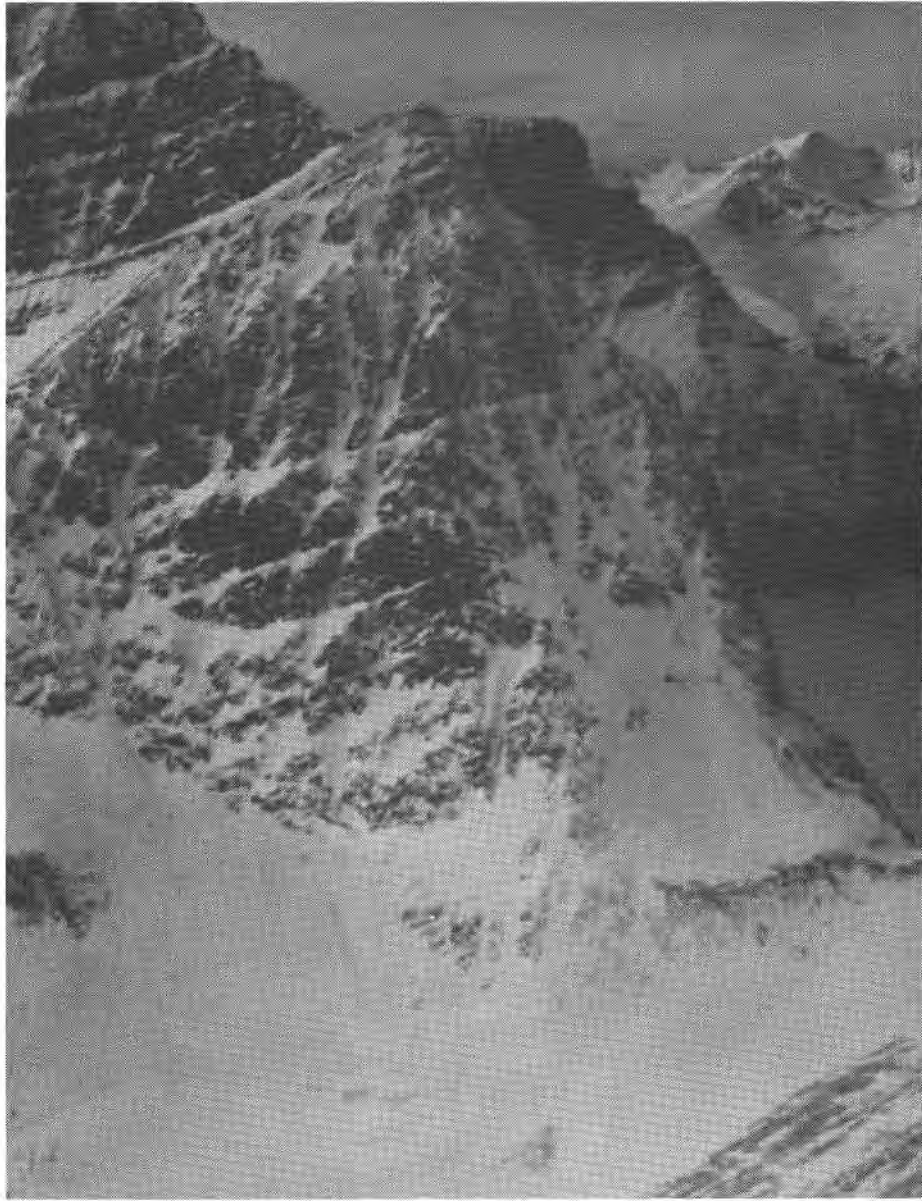


Figure 21 East Ridge of Mount Edith Cavell showing location of avalanche, 19 February 1972 (Photo courtesy Parks Canada)

Extensive property damage

WEATHER

Observations at Mount Norquay, Banff, 1700 m ASL

Date	Temperature °C		New Snow cm	Total Snow Depth cm
	Max	Min		
26 February am	-13	-27	8	150
pm	- 8	-14	1	149
27 February am	-11	-13	12	156
pm	-11	-19	14	164
28 February am	-19	-27	47	201
pm	-21	-24	5	201
29 February am	no readings taken			
pm	-21	-28	25	211
1 March am	- 4	-27	1	206
pm	- 8	-11		204

Snowfall and temperatures at Mount Norquay appear to be well correlated with those at the Sunshine Road, including Eagle Mountain, although the snowfall at Eagle Mountain is usually greater than that observed at Mount Norquay. The total snowfall during the winter 1971-72 in the Banff area would be observed or exceeded on the average only once in 70 years, and storms of the magnitude of that of 26-29 February are unusual for the area. Residents at Sunshine Village, 4 km from the accident site, described the storm as of disastrous proportions, with more than 100 cm of new snow, high winds, and extreme drifting. The base of the snowpack consisted of a 35 cm deep-depth hoar layer.

On 29 February helicopter bombing was carried out at the avalanche paths along the access road to Sunshine Village. The explosions released avalanches at the sites of Bourgeau No. 2, 3, 4, and 5, and all deposited snow on the road. Powder snow avalanches reached the road at Eagle No. 1 and Eagle No. 2. Owing to the continuing hazard the snow on the road was not removed.

ACCIDENT SUMMARY

On 1 March explosive control by helicopter was again carried out on the Bourgeau and Eagle avalanche paths; 6.8 kilo cannister charges were used, both singly and in combination in large multiple charges. At Bourgeau No. 7 the bombing released a very large avalanche that broke trees, expanded its path, and covered the road with extensive debris. Eagle No. 4 was then bombed and the ensuing avalanche engulfed the Bourgeau parking lot at the valley bottom. It destroyed a kiosk completely, brought down 1 km of powerline, buried 30 parked cars, damaged two 500-gal oil tanks, and destroyed 2 ha of forest. Because the road was closed no one was in the area.

AVALANCHE

The unusually deep accumulation of snow, heavy snowfall, and a weak base of snowcover provided the conditions for avalanches of catastrophic proportions. The avalanche started as a full-depth, dry slab at 2200 m ASL and ran to the parking lot at 1645 m ASL. The path has an average incline of 30 deg and a northwest aspect. The avalanche snow was up to 5 m deep on the parking lot. No previous occurrence of equal magnitude had been observed at this location, but tree growth leads to the conclusion that avalanches of similar size occurred about 50 years ago.

COMMENT

The destructive avalanche demonstrates that weather can be a serious constraint to the successful application of helicopter bombing. Avalanches should have been released artificially much earlier when they would have been small, but the continuing snowstorm prevented flying in time. When control work was finally carried out, a large, unmanageable avalanche had built up. Dropping explosives from a helicopter has proved to be a fast and inexpensive avalanche control method at Banff where a helicopter is available at all times close to the avalanche areas, but the continuous operation of a road or the safety of buildings should not depend on this method alone.



Figure 22 Avalanche path, Eagle No. 4, with Bourgeau parking area at the bottom, Sunshine area, Banff, Alberta. (Photo Bruno Engler)

Three occupants of a vehicle killed

WEATHER

Observations at Hope, Kawkawa Lake, 142 m ASL

Date	Temperature °C		Precipitation
	Max	Min	mm
1 March	3.5	-5	19
2 March	4.5	-5	1.8
3 March	4.5	0.5	0.5
4 March	5	0	28
5 March	4	0	80

About 70 cm of new snow had been observed at the mine. Heavy rain fell on 5 March.

ACCIDENT SUMMARY

Giant Mascot Mine is in the Coast Mountains in an area of heavy snowfall, and is reached by a road 8.4 km long from the Trans-Canada Highway. Between km 4.8 and km 7 the road crosses a steep hillside with bluffs where avalanches occur frequently.

On the morning of 5 March the bus carrying the crew was blocked en route to the mine by an avalanche at km 5.5. The bus returned to Hope with all passengers but three who had to complete urgent work at the mine. A bulldozer cleared the road of avalanche snow and the three men followed in a pick-up truck. The truck waited in safe areas between avalanches while the bulldozer worked on the snow deposits, and when a stretch of road was open the truck would move to the next safe spot. During one of these moves, at km 6.3, the truck was hit by an avalanche, burying it completely.

RESCUE

The bulldozer operator observed the avalanche as it hit the truck, but because the road was narrow and bordered by steep hills he could not turn his machine around to push away the heavy wet snow immediately. Furthermore, the bulldozer carried no snow shovel. Helpless, the operator walked to the mine about 1 km away and called for additional men.

The rescue workers dug with shovels and bare hands to uncover the cab of the pick-up truck with the roof crushed by the snow, the windshield pushed in, the rear window broken, the driver's window pushed out, and the interior choked with snow. The three occupants were dead, completely encased in the avalanche snow. This was about 2 h after the avalanche had struck.

Autopsies performed on the bodies indicated that in all three instances death had occurred from carbon monoxide poisoning. It was presumed the snow had packed so tightly about the driver that he was unable to turn off the ignition. The carbon monoxide gas must have built up rapidly in the snow-encased vehicle before the engine stalled from lack of oxygen.

AVALANCHE

Heavy snowfall followed by high temperatures with rain caused the avalanche, which started at an altitude of about 700 m ASL, 100 m above the road, and removed about 100 cm of deep snow on the surface of the snowcover. The total depth of snowcover was greater than 2 m.

The average incline of the track was 40 deg, and the wet avalanche snow covered only about 20 m of the road to a depth of up to about 10 m. The snowbank at the edge of the road stopped much of the snow and contributed to the deep deposit.

COMMENT

People in vehicles have usually a better survival chance than those on foot or on skis, but as this case demonstrates heavy wet snow falling over a steep slope can crush a vehicle and entirely encase the occupants. The avalanche was narrow, but the truck happened to be exactly in its path.

Rain and high temperatures after a heavy snowfall as well as the number of avalanches that ran that day should have made obvious the high avalanche hazard. Under these circumstances the road should not have been used and snow removal work delayed. The bulldozer operator was actually much more exposed to avalanches than the riders of the pick-up truck, but luckily he escaped any encounter.

The accident demonstrates the importance of having vehicles and machines equipped with snow shovels, and preferably with a probe. With a shovel the bulldozer operator would have been able to dig quickly to the cab of the buried vehicle, although in this case his help would probably have come too late. It is not sufficient to equip vehicles with shovels at the beginning of the winter. Frequent inspections must ensure that the tools are still there later in the season.

Four skiers killed

WEATHER

Chart Readings at Whistler Alpine Station, 1870 m ASL

Date	Temperature °C		New Snow cm	Wind Speed km/h	Wind Direction
	Max	Min			
4 April am	1	- 3	5	8-24	SE
pm	-0.5	- 1.5	5		
5 April am	0	- 2	28	8-56 (max 104)	SW
pm	no readings taken				
6 April am	0	- 9	30	16-24 (max 104)	SE
pm	-6	- 8.5		0-16	SE
7 April am	-7	-10.5	15	0-16	SE
pm	-1.5	-10.5	7.5	8-24	SE
8 April am	-8	-10	2.5	8-24	SE
pm	-7	- 9.5	10	48-56 (max 80)	SE

AVALANCHE OBSERVATIONS

- 4 April - no avalanche control, no occurrences observed
- 5 April - medium size occurrences on NW to NE indicator slopes
- Alpine region closed in mid-morning due to high winds
- 6 April - medium size occurrences noted on N indicator slopes
- attempts to control Alpine T-Bar area abandoned
- 7 April - medium size controlled occurrences on N and NE slopes
- one large controlled avalanche on a NE slope that has infrequent occurrences
- 8 April - no occurrences noted

On 7 April the weather was overcast with snowfall in the early morning, then cloudy. Excellent powder skiing prevailed. Owing to the

high hazard "closed avalanche" signs were placed on the traverses across the north side of Whistler Peak and the Kaleidoscope traverse, but the enforcement of closures was difficult because of persistent powder skiers. The next day, 8 April was cloudy with some sunny periods, but at 1450 h a squall dropped 10 cm of snow in 1 h on the alpine region. After the squall, all old tracks above the treeline were obscured, but no avalanches were observed and ski testing of indicator slopes produced no results.

ACCIDENT SUMMARY

The accident was unobserved, but at 1810 h on 8 April a man and wife were reported missing by a friend when they failed to pick up an infant left with the mountain baby-sitting service.

RESCUE

The RCMP was notified at 1810 h and the ski patrol at 1900 h. The friend reporting the lost couple indicated that they had intended to ski in the West Bowl area. At 1930 h two other people were reported missing by friends who said that the four missing skiers knew each other and had been seen together at 1300 h in the Round House area.

By 2030 h seventeen searchers had gathered at the bottom of the mountain for a standard night search. At 2145 h the search parties left the top of the mountain, checked likely areas, and reported in by 0200 h on 9 April. Because the search was considered thorough, it was decided to postpone further operations until daylight when an extensive aerial search of the alpine areas could be made.

At 0615 h on 9 April the search was resumed by helicopter. It covered all alpine areas, but no evidence of tracks or avalanche activity could be found. Flat light hampered the observations at times, but in general the visibility was good. At 0800 h the helicopter returned to the base to allow the observers to organize a ground search. At 0845 h the first volunteer search parties were despatched to the alpine area and at the same time another aerial search was carried out. Efforts concentrated in the West Bowl, but several parties were sent to other possible areas. About noon on the 9th it started to snow again, with light winds.

As a result of a radio appeal for any information about the four missing skiers reports were received at 1530 h indicating that the party had been seen at the top of the Alpine T-Bar at 1440 h on 8 April and probably on top of a ridge bounding the Back Bowl at 1450 h. The search then concentrated in the Back Bowl area. At 1900 h all searchers reported at the bottom of the mountain and the operations were called off until morning.

At 0700 h on 10 April the search was resumed; the snowfall had continued during the night and continued throughout the day. The search co-ordinators, now having three helicopters and two RCMP search dogs at

their disposal, concentrated their efforts in the areas accessible from the party's last-seen point.

At 1200 h dog No. 1 was sent to check avalanche deposits found by a ground party in the Burnstew Basin area. Dog No. 2 was sent to avalanche deposits in the Back Bowl near the area where the skiers had last been seen. This area is 400 m west along the ridge from the last-seen point, in the opposite direction to the usual traverse. The dog was in action at the site at 1300 h, the handler instituting a grid pattern search working down from the top of the debris area. The avalanche snow was disguised by new snow and rescue personnel had difficulty defining it. At the same time all other ground search efforts were withdrawn because the searchers had started a number of new avalanches and the hazard was increasing.

At 1430 h dog No. 2 located the first victim and at 1500 h the second one. By 1515 h the two remaining victims had been discovered. All were buried about 1.2 m below the snow surface, face down, heads downhill, in a line across the hill, separated from each other by about 2 m. The bodies were transported from the area in toboggans and over-snow vehicles. Death in each case was caused by suffocation, although all had also sustained multiple injuries.

AVALANCHE

The avalanche was probably formed by the short snowfall accompanied by extremely strong wind in the afternoon. It had fractured at an altitude of 1870 m, with an estimated depth of 1.0 m in the wind-deposited snow. A dry soft slab, it ran in an unconfined manner with a width of approximately 50 m over 80 m vertically. The slope has a northwest aspect and approximately 35 deg inclination in the starting zone. The deposit had a maximum depth of 1.5 m, was of a uniform consistency and only just firm enough to allow walking over the surface. The avalanche was probably triggered by the skiers themselves.

COMMENT

The weather and the snow in the morning of 8 April did not indicate a high avalanche hazard, and skiing in uncontrolled areas could be undertaken by experienced skiers with the usual precautions. The sudden squall, with high wind and intense snowfall in the afternoon, changed the avalanche hazard from low to high in a very short time. It shows that skiers and mountaineers must watch for changes in weather during the day and continuously re-assess the stability of the snow.

The party made a common error of groups crossing avalanche terrain: there was insufficient space between them. If a distance of 25 to 30 m had been maintained between skiers only one or two of them would have been caught in the avalanche so that they could have been rescued immediately by the others. All the victims' ski bindings had released, but the skis were still attached by safety straps and the poles were attached by the wrist straps. It is not possible to tell whether freedom from this

equipment would have assisted in survival, but skis and poles definitely act as anchors and decrease chances of remaining at the surface of an avalanche.

The large-scale search involving varied personnel illustrated the importance of recording on a map the areas that are covered in the search and the need for double checking the coverage on the return of the search parties. It was found later that one party dispatched to the Back Bowl on 9 April had not actually covered the entire assigned area. The case showed also that reports of witnesses must be treated with caution. The initial information had placed the missing party at the West Bowl 5 km from the accident site, and subsequent reports had indicated several different areas.

The reason for the long search was that the avalanche deposit was very difficult to recognize. Several people had skied over the area without noticing it, and only when an experienced mountaineer was close to the fracture line could he recognize it as such. The fracture line was not even visible from the run-out zone 80 m below. Once again a dog proved to be most effective in finding the buried victims.

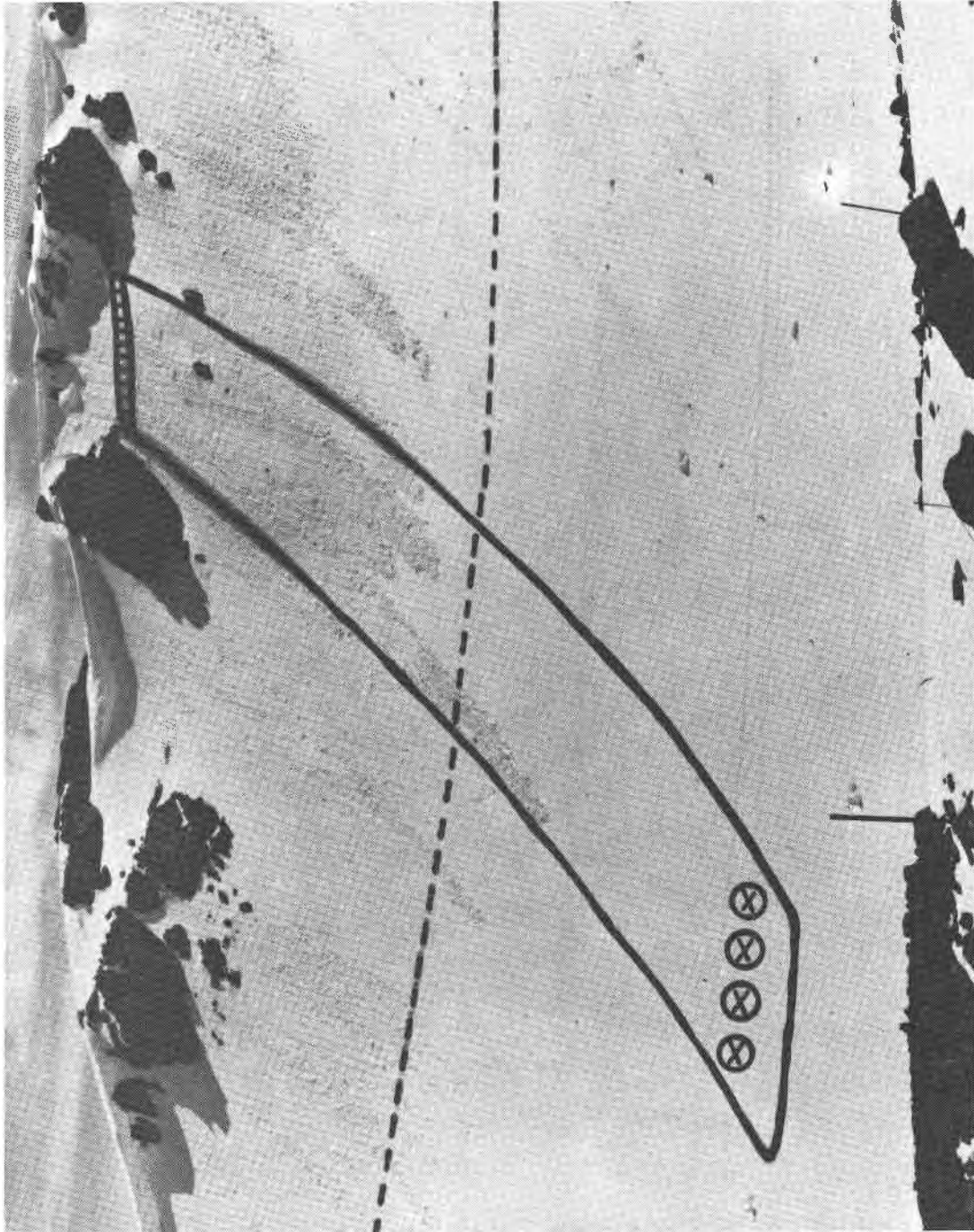


Figure 23 Avalanche site showing location of fatal avalanche. The dashed line is the traverse usually taken by skiers prior to accident. X location of victims.

One skier killed

WEATHER

Observations at Nelson 2 Climate Station, 602 m ASL

Date	Temperature °C		Precipitation mm
	Max	Min	
19 April	14	-1.5	
20 April	15	3	
21 April	13	1.5	5.5
22 April	11	0	
23 April	15	0	

Observations in the Apex Basin on the afternoon of Wednesday, 19 April showed a well consolidated snowpack with surface hoar. No avalanches were observed at this time. On Friday, 21 April, 40 cm of snow fell on the mountain. On Sunday morning, 23 April, the temperature was estimated at 2°C, the sky was clear and the wind was gusting from the north. The top 5 cm of snow were reported to be wet.

ACCIDENT SUMMARY

At 0900 h on 23 April a group of skiers left the base of Ymir Mountain by helicopter and landed below the peak at 2070 m ASL. The group intended to ski Ymir Mountain and had instructions to stay on the east side of the basin. One member of the party who had skied the area before decided to descend with his son in a gully to the west of the party. The son entered the centre of the gully and his father followed in approximately the same traverse. Suddenly, the son noticed the snow moving under him, causing him to fall. His ski came off, snagged a tree, and the safety strap prevented him from being carried very far. His father, however, was carried past him in the moving snow, and when it came to rest was nowhere to be seen.

RESCUE

After calling for his father and looking briefly over the debris, the son skied down 2 km to the lower helicopter landing site to call for help. All available skiers were moved to the accident site by helicopter and snow-cat, formed probelines, and by probing with skipoles and pine snags

found the victim 90 min after he had been buried. His head was about 35 cm below the surface, face down. The mouth and nose were packed with snow, and both skis and poles were attached to the body when he was recovered. Cardiopulmonary resuscitation was attempted by a doctor and members of the ski patrol, but no signs of life returned. Suffocation was determined as the cause of death, but the victim was probably unconscious before the avalanche came to rest because examination indicated that he had been hit on the head by his ski.

AVALANCHE

The avalanche was the result of a 40 cm deep snowfall on a layer of surface hoar two days before the accident and high temperatures on the day of the accident. The fatal avalanche was triggered by the two skiers, but three additional natural avalanches had occurred on the same day.

The slab avalanche fractured at an altitude of 1930 m, with a width of 60 m and a depth of 40 cm. The avalanche snow was mixed dry and wet and up to 1.8 m deep in the run-out zone. The avalanche path had a length of about 100 m, an average gradient of about 38 deg, and was channelled. The aspect was north.

COMMENT

The accident was the consequence of a bad choice of route. The victim could have avoided the avalanche by skiing with the rest of the group over the ridge to the east of the gully. Gullies are hazardous because they catch drifting snow, have steep slides on which the snow slides readily, and channel the moving snow. Anyone caught in the channelled snow is usually buried deep.



Figure 24 Apex Basin, 23 April 1972. People on the deposit begin the search. Three additional natural avalanches may be seen at right (Photo courtesy Brian Clarkson, Nelson, B.C.)

One skier buried

WEATHER

Observations at Whistler Alpine Station, 1870 m ASL

Date	Time	Temperature °C		New Snow cm	Snow Depth cm
		Max	Min		
13 February	0900	-5	-10.5	T	-
	1400	-4	- 7	T	292
14 February	0900	-1.5	- 6		
	1400	-1.5	- 4.5	T	289
15 February	0900	-3	- 5.5	0.5	
	1400	-4	- 5	1	289
16 February	0900	1.5	- 4	1.5	
	1400	1.5	0.5		287
17 February	0830	1.5	- 5.5	5	
	1430	-4	- 6		294

On 16 February the sky was overcast, with mixed rain and snow. Approximately 1½ cm of new snow fell but melted during the day; there was little wind. The temperature dropped to -5.5°C over night and 5 cm of snow fell, then it cleared again on the morning of 17 February. Winds on the morning of the 17th were estimated at 8-16 km/h from the south, dropping to calm during the day; no avalanche activity was noted and the hazard was thought to be low. At 1430 h the temperature was -4.5°C.

ACCIDENT SUMMARY

A single skier ascended part way the low traverse to Whistle Bowl on the north side of Whistler peak with the intention of skiing down the steep slope below. He was descending from the traverse when, about one quarter of the way down the pitch, he heard a rumbling sound and looking back uphill saw the whole slope moving around him. Swept downhill by the moving snow, he found himself able to stay on top by using a swimming motion until the last minute when he was dragged down and buried. The time was 1400 h.

RESCUE

The avalanche was observed by people riding the Alpine T-Bar who reported the accident to a ski patrolman immediately upon arrival at the top. He in turn reported it to the alpine office by telephone and the prepared avalanche rescue plan was activated at once. Meanwhile, the patrolman and three of his fellows collected hasty search packs stored at the upper T-Bar terminal and proceeded to the accident site.

Probe lines were set up at 1410 h. One eyewitness who had prior avalanche experience in Europe was given a probe to check the area in which he thought the victim might be buried. At 1413 h a follow-up team, including a doctor, arrived at the site carrying resuscitation equipment and extra probes and shovels.

At 1420 h the eyewitness located the victim buried in a crouched position with his head about 0.6 m below the surface. One ski was still attached to the boot and one pole to the wrist. The man was dug out in a conscious state, able to speak, but shortly lapsed into unconsciousness. The doctor immediately applied oxygen and the victim soon regained consciousness. The only injury sustained by the victim was a slight head cut from a shovel when he was dug out.

Probing was continued until 1630 h to ensure that no others had been buried and the area was further checked by search dogs the following morning.

AVALANCHE DATA

The avalanche, triggered by the skier, ran on a crust created by above-freezing temperatures with mixed rain and snow during 16 February and below-freezing temperatures that night. New snow, probably combined with some southerly or southwesterly wind overnight, created the slab. The avalanche fractured at an altitude of 1885 m through a depth of 5-30 cm of new snow, was approximately 45 m wide, and ran approximately 100 m on an open slope, depositing snow to a maximum depth of 2 m. The slope gradient in the release area was about 40 deg and the aspect north.

COMMENT

Light snowfall in the alpine area during the night of 16 February illustrates the importance of minor storms as potential hazard builders, especially in ski areas. Several skiers had crossed the traverse without accident on 17 February before the victim did. The lone skier was lucky to be observed when he was caught in the avalanche and his successful recovery was due partly to the eyewitness, who clearly established the last-seen point at the site, and partly to the well prepared avalanche rescue plan and equipment of the Whistler Mountain ski area. The search equipment located at the top of the highest lift definitely contributed to the speed of the operation

An additional note, the buried skier's hands were still in the pole wrist straps and this may have contributed to his burial.

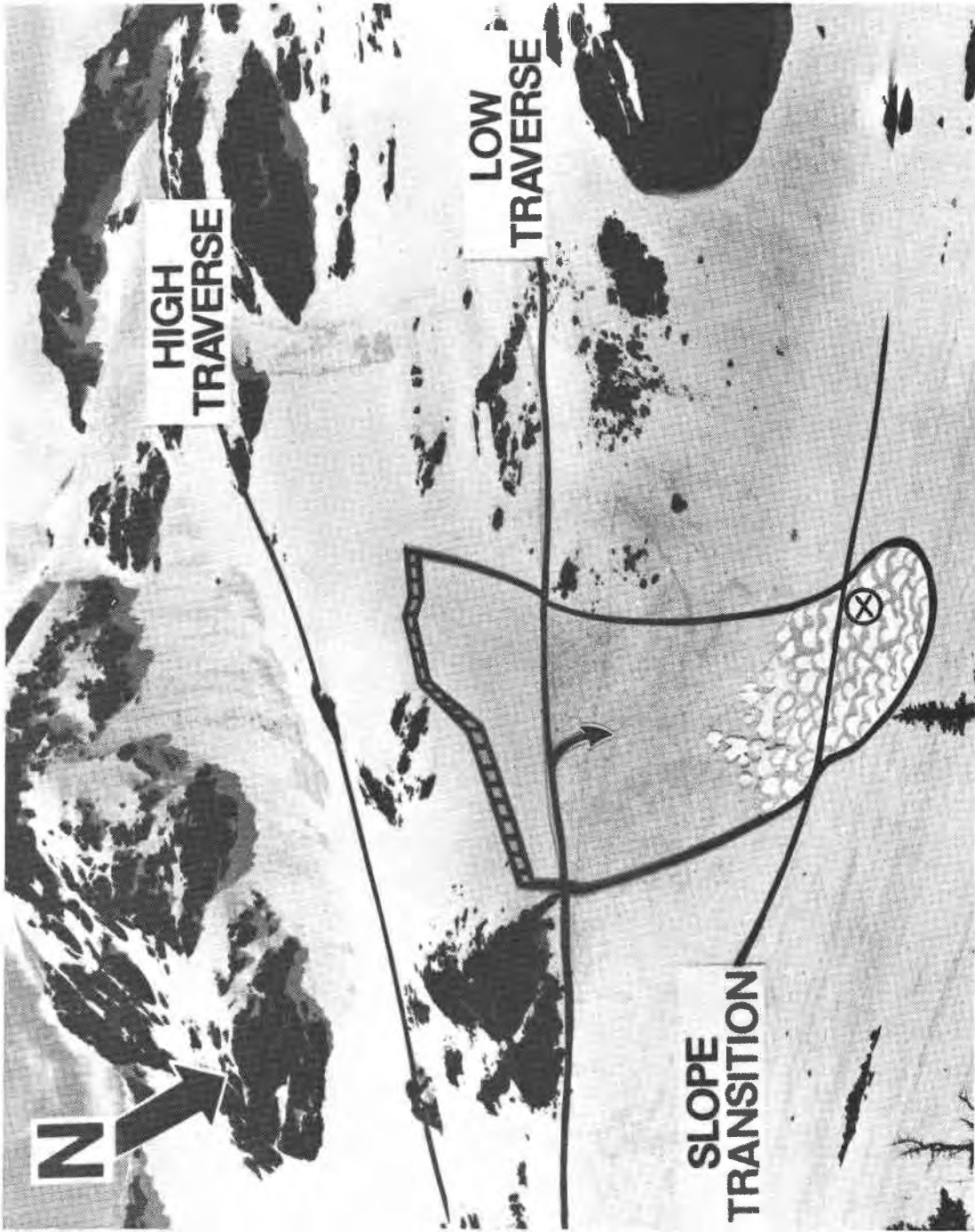


Figure 25 Avalanche at Whistler Mountain, B.C., 17 February 1973.
⊗ Location of buried skier.

One skier killed

WEATHER

Observations at Lake Louise-Temple Warden Station, 1980 m ASL

Date	Temperature °C		New Snow cm
	Max	Min	
5 Dec	-6	-13	
6 Dec	-6	-14	1
7 Dec	-3	- 8	6
8 Dec	-2	-14	9
9 Dec	-9	-16	

ACCIDENT SUMMARY

The accident was not observed. The victim was skiing alone on the southwest ridge of Bow Summit and presumably triggered an avalanche that engulfed and buried him. He had not registered with the National Parks services.

RESCUE

The victim's car was parked for several days near the radio repeater station between the Banff-Jasper Highway and the Peyto parking lot. Investigations led to the conclusion that the driver had probably been lost while skiing in the area.

On 18 December a search was initiated in the area of the Peyto parking lot. When no clues were found a large-scale search was organized, using dogs, personnel on skis, and motorized toboggans. On 19 December a survey by helicopter located a large avalanche deposit above Peyto Lake. Some helicopter bombing was carried out and an avalanche was released on an adjacent north slope.

On 20 December personnel and search dogs were flown to the north slope deposit. During the search a dog triggered a large full-depth avalanche which ran onto Peyto Lake. On 21 December the search was continued in the same area and in the lower deposition area near Peyto Lake.

On 22 December the searchers moved back to the parking lot and began sectional dog search patterns west of the parking area. After 2 h a dog located the victim in an old avalanche deposit 40-70 cm below the new snow surface. The dead skier had severe head injuries, and it was assumed that he had been unconscious when he was buried in the shallow avalanche, could therefore not free himself, and died from exposure. The body of the victim was removed to Banff and the search concluded.

AVALANCHE

The avalanche that caused the accident and others that occurred during the search were attributed to a weak base of depth hoar in the snowcover, a common phenomenon in the Rocky Mountain area. The avalanches removed the full snowcover to a depth of about 60 cm. The fatal one occurred in a small basin with westerly aspect, a slope incline of about 35 deg, and an elevation of 2,210 m. Its size could not be established because about 40 cm of new snow had fallen since the accident and made the identification of the deposit difficult.

COMMENT

Although the victim had some mountaineering experience he neglected to inform anybody about his plans, and he skied alone. Skiing alone proved to be a serious mistake.

Buildings destroyed, several buildings heavily damaged

WEATHER

Observations at Bugaboo Creek Lodge, 1490 m ASL (20 km SE of Mine)

Date	Temperature °C		New Snow cm
	Max	Min	
11 January	-21	-38	1
12 January	-15.5	-26.5	26
13 January	0	-19	41
14 January	3	- 2	25
15 January	4	0	
16 January	2	0.5	11

Approximately 140 cm of new snow fell at the mine during the four days previous to 16 January. Periods of strong wind and temperatures around 0°C were observed.

ACCIDENT SUMMARY

At approximately 0230 h on 15 January a loud rumbling was heard in the camp area. Investigation the following morning revealed that an avalanche from the Charlotte path had damaged the office building and another a fuel tank and a van. The oil shed, metals laboratory and mill also were damaged by an avalanche from the Sheba path.

At 2230 h on 15 January Bunkhouse 1 was shaken by another avalanche. On investigation it was found that both Bunkhouses 1 and 2 had been hit and seven rooms destroyed in Bunkhouse 2. Fortunately they were unoccupied at the time. The avalanche, from the Vermont East path, seemed to have jumped the roof of Bunkhouse 1.

At 2042 h on 16 January the power house was hit and buried and power went off at the camp. The mine crew then withdrew underground into the mine to spend the night. Daylight revealed that the power house was completely buried, a major section of the mine dry missing, the machine shop badly damaged, the storage building and oil shed missing, the mill damaged, and the metals laboratory further damaged. Excessive amounts of snow and surface variations made it clear that more than one avalanche had occurred in the area.

In all, six buildings were destroyed, six heavily damaged, and various equipment destroyed or damaged. The total loss was estimated at \$600 000. Fortunately there was only a small maintenance crew at the mine and the mill was shut down. None of the employees was injured.

AVALANCHE DATA

The avalanches were caused by heavy snowfalls, strong winds and temperatures around and exceeding 0°C. A surface hoar layer had formed on the snow base prior to the new snowfalls. The mine settlement itself lies at 1640 m ASL on Vermont Creek, and the avalanches start at elevations varying between 2000 and 2600 m ASL. The Sheba and Ruth avalanches present the greatest threat to the installation. Those of 16 January (on these paths) probably contained dry, light snow, carrying through the air; they did not deposit snow on the road above the camp and appeared to have landed directly on the powerhouse.

COMMENT

The original mine camp was built at this location in 1926 and there is no record of its being hit by an avalanche. The modern camp was opened in 1965. It was larger than the old camp and extended into unsafe areas. During the winter of 1967-68 an avalanche, possibly from Sheba, destroyed one building in the vicinity of the oil storage. On 7 December 1970 the powerhouse roof was blown off by an avalanche from the Ruth path and another from Sheba later in the year narrowly missed the oil storage.

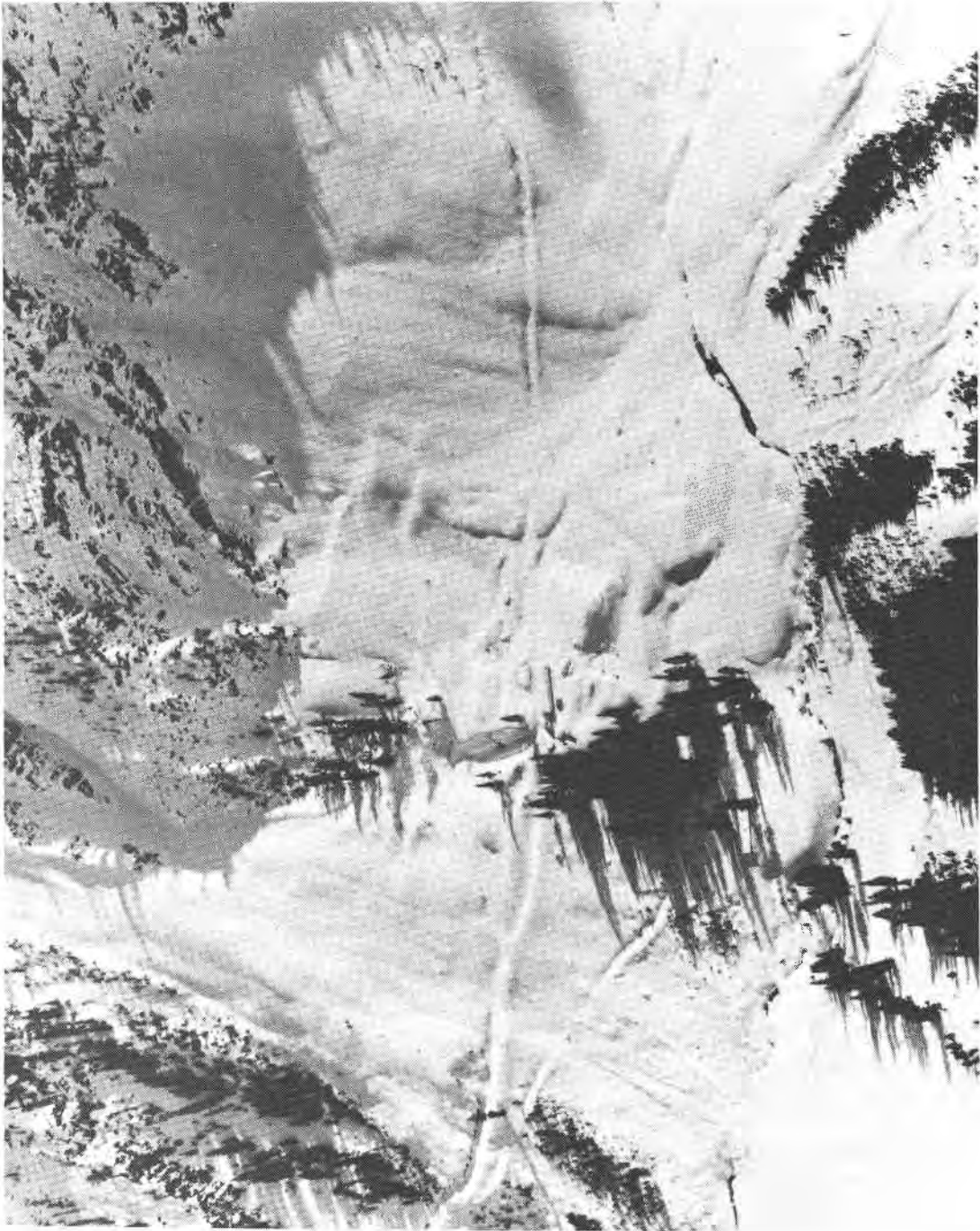


Figure 27(a) Ruth-Vermont Mine, looking south-east, March 1969. Buildings are clustered round patch of trees between Charlotte (left) and Ruth avalanche paths.

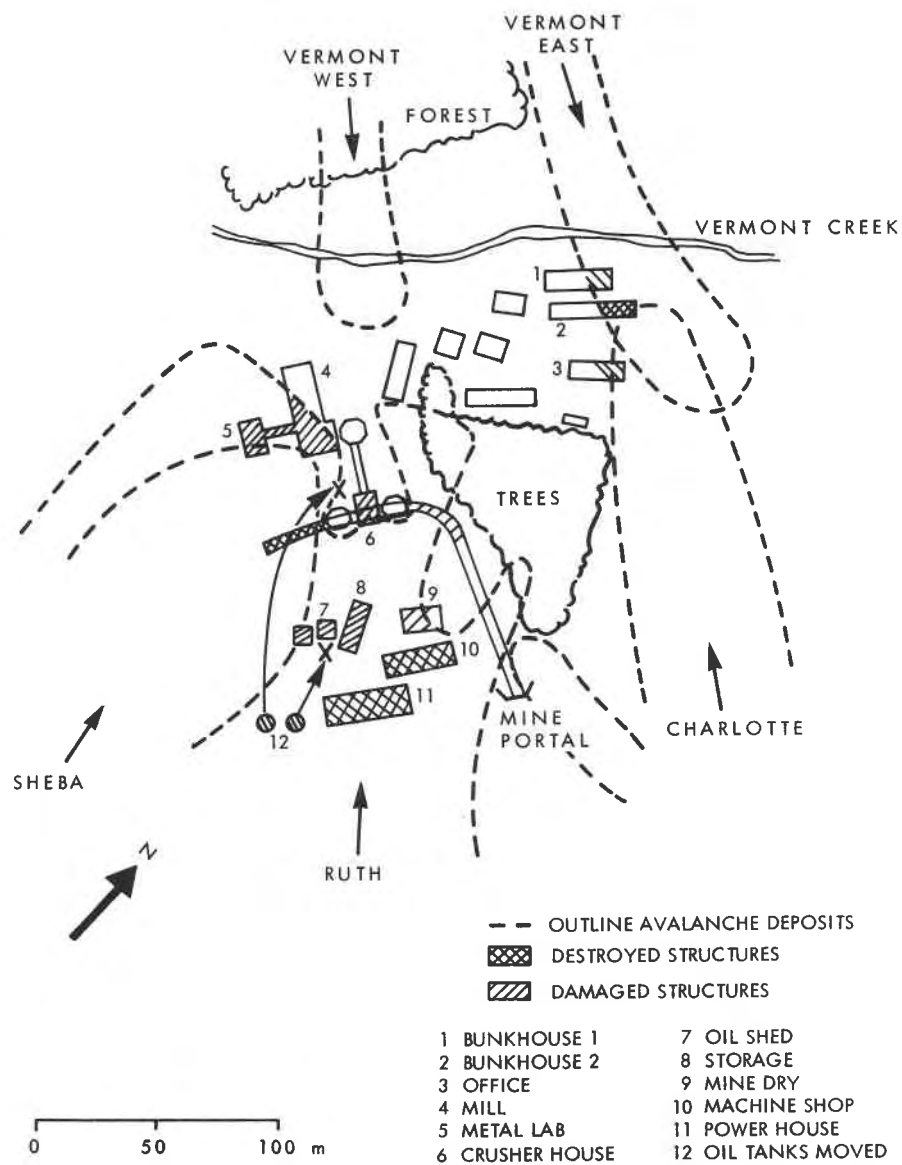


Figure 27(b) Plan of mine showing outline of avalanches, 16 January 1974.

Seven occupants of a building killed, one rescued unharmed,
buildings destroyed

WEATHER

Observations at Terrace Airport, 219 m ASL

Date	Temperature °C		New Snow cm	Rain mm	Precipitation mm
	Max	Min			
15 January	-16	-24	14		10.9
16 January	-17	-27	14		9.6
17 January	-12	-20	99		63.2
18 January	0	-24	22		15.5
19 January	0	- 4	9		7.1
20 January	- 2	- 4	6		4.8
21 January	0	- 4	6		5.8
22 January	3	- 4	40	0.3	26.9

The accident site is 45 km west of Terrace on Highway 16 to Prince Rupert and experience has shown that snowfalls there are usually greater than those at Terrace Airport. At the microwave station, McLean Mountain, elevation 1130 m and 37 km west of the North Route Cafe, the temperature was -6 to -3°C between 17 January and 21 January, then it climbed to 0°C on 22 January.

ACCIDENT SUMMARY

Between 2100 h on 21 January and 0800 h on 22 January 40 cm of new snow fell at Terrace, making driving and snow removal difficult on the highways. The mail truck left Terrace for Prince Rupert at about 0130 h. Enroute, it overtook a car driven by a businessman from Prince Rupert who was unable to negotiate the road. Abandoning his vehicle he continued his journey in the mail truck. At the North Route service station, at km 45, the two occupants of the mail truck met another Prince Rupert businessman with a 4-wheel drive pickup truck. The group proceeded west in convoy to km 55 where they encountered a truck-plow attempting to clear the road of avalanches. It became evident that the plow would be unable to clear the road, and it was decided to abandon it since it was trapped between slides.

The group, now four strong, returned to the service centre at 0530 h to wait out the storm. The service centre contained a coffeeshop, service station, and motel and was occupied by the owner, his daughter, a cook, and a machine operator. The travellers settled down in the coffee-shop, passing the time napping, playing cards, and drinking coffee.

At 0800 h the four guests and the short-order cook were in the cafe, the owner and the machine operator were in the back of the building, where also the daughter lay sleeping. Shortly after 0800 h a loud "crack" was heard and suddenly all were tumbling through snow.

RESCUE

At approximately 0950 h on 22 January a helicopter, which was checking for broken telephone lines along the Skeena River, came across the avalanche debris. The local Royal Canadian Mounted Police were immediately informed that no signs of life could be seen in a rapid check of the area.

At 1000 h the call for manpower and equipment was put out to various provincial and municipal groups. At 1030 h the first party, consisting of police, a search dog, and a first-aid unit, was dispatched to the scene. At 1045 h the first follow-up column was dispatched with equipment that included probes, shovels, radios and snowshoes. At 1130 h the area had been searched by the dog to no avail. Twenty men were on site with probes and shovels by 1330 h.

Probing was exceedingly difficult. The avalanche snow ranged from 1 to 8 m in depth and was strewn with housing debris and trees up to 0.5 m in diameter. Front-end loaders and shovels were then used to clear the debris to ground, beginning at the westerly extremity of the avalanche. With the possibility of further releases, a guard was posted.

At 1445 h the body of the truck-plow operator was located, face down, buried under 3.6 m of snow. At 1515 h the mail truck driver was found alive, in a sitting position, under 1.5 m of snow; he was removed by helicopter to the hospital. The cook's body was located, face down under 2.5 m of snow at 1630 h. By 1645 h there were approximately 65 rescuers on site. At 1730 h the body of one of the businessmen was located beneath 5 m of snow. As dark loomed and the guard could no longer observe the avalanche path, a temporary halt was called at 1800 h for instruction in means of survival if another avalanche should occur. Work was later resumed, and at 2355 h the body of the machine operator was recovered, buried face down 3 m deep.

At 0230 h on 23 January the owner's body was recovered, lying sideways under 3 m of snow and debris. The body of the second businessman was located at 0310 h, face down under 5 m of debris. At 0330 h the body of the daughter was found, face up in bed, below a portion of roof under 1.8 m of snow. At 0630 h the search was suspended owing to steady rain, uncertainty of avalanche hazard, and the fact that all persons known to have been at the site were accounted for.

A meeting of rescue and experienced avalanche personnel was held later on 23 January and it was decided that explosive control of the slopes above the site should be carried out. After helicopter bombing on the morning of the 24th, with no significant results, the clean-up search was resumed and completed without locating any further victims.

AVALANCHE PATH

The avalanches at the North Route Cafe originate in a large cirque that contains several independent starting zones. Where the avalanche of 22 January 1974 started could not be established exactly, but the most likely place is a steep slope between 1100 and 1200 m elevation on the west side.

The avalanches are funnelled into a 50 m wide, straight, steep-sided valley opening into an alluvial fan 650 m uphill from the service centre. The alluvial fan has an inclination of 14 deg. Most avalanches run out on it and usually have not come closer than 300 m to the service centre. Scattered poplar trees and broken wood on the lower part of the alluvial fan demonstrate, however, that avalanches had reached the highway and railway line before the service centre was built, through two narrow gaps in the coniferous forest (Figure 28). The westerly gap, 10 m wide, is in a straight line with the direction of the narrow valley above and was obviously created by fast dry snow avalanches that did not change their direction of motion after leaving the valley. The easterly, 25 m wide gap was probably made by slower wet snow avalanches, which would tend to follow the fall line over the side of the alluvial fan. In 1971 and 1972 avalanches reached the highway through this opening 60 m east of the service centre.

The service station-cafe-motel complex was built underneath the westerly opening of the dense forest, and in the path that dry, rapidly-moving avalanches would be expected to take.

AVALANCHE

As is usually the case for large destructive avalanches, that on 22 January 1974 was the result of a combination of several weather factors:

- Unusually deep snow. The total snowfall at Terrace Airport for January 1974 was a new record for the month.
- A heavy snowstorm that deposited 135 cm of new snow between 16 and 18 January and 60 cm between 19 and 22 January at Terrace Airport. At the North Route site the snowfall was probably greater by one third.
- A high precipitation rate of 2.8 mm/h between 2100 h on 21 January and 0800 h on 22 January.
- Low temperature during the week previous to the snowstorm, rising to 0°C during the storm.
- Moderate wind.

The avalanche moved through the forest above the service centre without breaking fir trees with diameters greater than 0.5 m, but it stripped the trees of their branches up to 10 m above ground. The average depth of avalanche snow in the area surrounding the buildings and on the highway was 1 m, but the snow was up to 8 m deep at the buildings, probably because it was caught by plowed snow and the structures. The avalanche ran out on the ice of the Skeena River, with the tip of the deposit 250 m past the service centre. These observations lead to the conclusion that the avalanche must have contained dry snow with a rather low density, probably between 20 and 50 kg/m³. The estimated speed of the avalanche when it hit the buildings was 30 m s⁻¹ (108 km/h).

COMMENT

The service centre was located in the run-out zone of large avalanches that would probably occur once in about 15 years. Damage to the forest above and below the service centre clearly indicated that avalanches had reached the site before. The growth pattern of the trees, obvious on air photos, also indicates an avalanche site. Unfortunately, the hazard was not recognized when the service centre was built about 1964, and later when avalanches did come close the warning went unheeded.

The disaster initiated an extensive and successful safety and control program for British Columbia highways through the Ministry of Highways and Public Works.

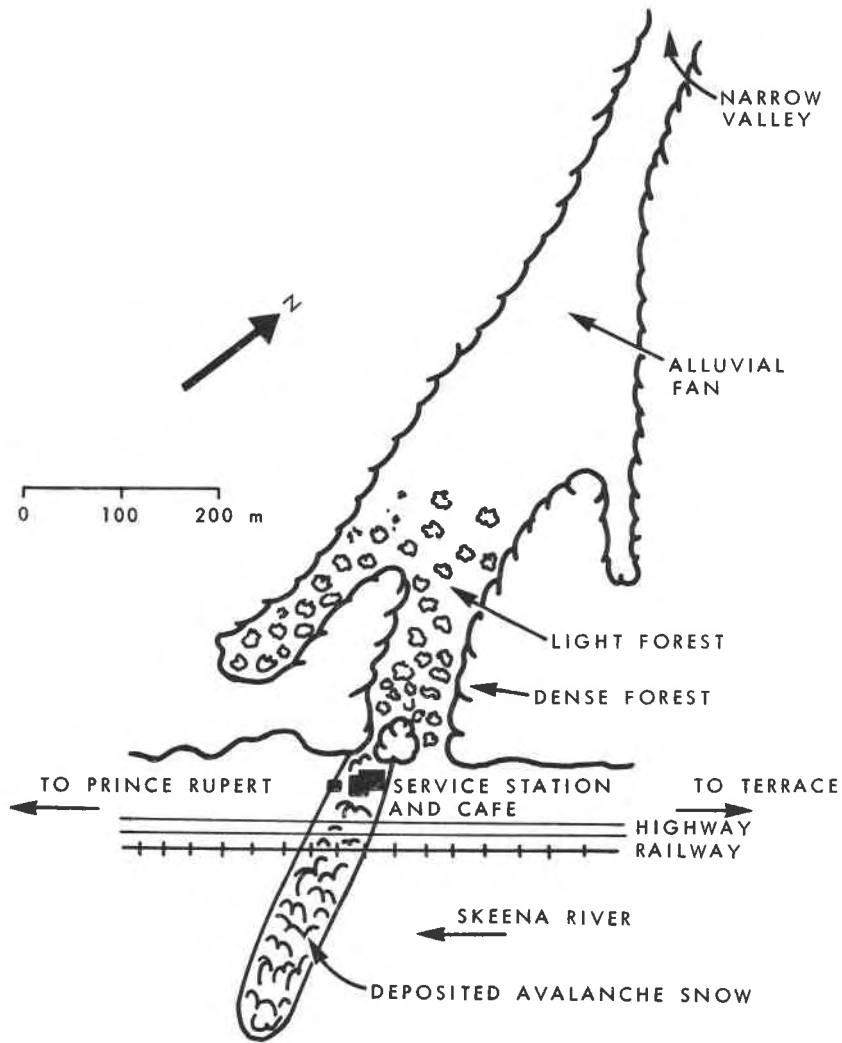


Figure 28 Avalanche site at North Route Cafe,
22 January 1974

One skier killed, two skiers injured

WEATHER

Friday, 15 February, was a cool day with about 5 cm of snowfall. The mountain was skied for the first time that winter by numerous skiers and no avalanche occurrences were noted. Sunday, 17 February, was fairly warm, not unusual for that time of the year. Light snowfall had occurred since the 15th. The weather station at Blue River, elevation 681 m ASL, reported 7 cm of new snow.

ACCIDENT SUMMARY

About noon on 17 February three groups of skiers landed by helicopter on Mica Mountain with the intention of skiing the same south-east slope as on the previous Friday. The old tracks could still be seen. Each group comprised a guide and nine clients, and all carried avalanche rescue transceivers.

Guide 1 descended with his group on the northeast side of the slope, entering the avalanche track about halfway down. Towards the bottom he skied with a slower member of the group while the rest of his clients waited below and to the side. Guide 2 took his group to the southwest side of the slope and into the trees along the edge of the path.

Guide 3 entered the slope from the top corner (see Figure 29) in order to test the snow. One skier requested permission to advance because he wanted to take movie pictures of his companions. After checking the slope the guide said it was all right to go down a couple of hundred feet. As the photographer set up his camera four other skiers entered the top of the path. Suddenly the whole slope fractured around them; the four skiers, the guide, and the photographer were caught in the moving snow.

As the avalanche flowed down it gained momentum and developed a powder component that caught one skier of group 2 and slammed him through the small trees. The powder avalanche advanced further down the slope than the flowing part and struck Guide 1 and one of his clients, who, completely unprepared, tumbled over the snow.

RESCUE

When the snow had stopped, Guide 3 was partly buried but was able to dig himself out. He scanned the slope quickly, noting in the same area the four skiers, all partly buried, one with only a hand showing. There was no sign of the photographer.

With the guide's help the four were immediately freed and prepared for a systematic search with rescue transceivers. One skier whose injury would not allow movement was left at the site while the others moved slowly down the slope with the guide, transceivers switched to receive. About 25 min after the avalanche had occurred the buried skier was located under about 1 m of avalanche snow, in a standing position, unconscious, and not breathing. Artificial respiration was immediately initiated. So tightly packed was the snow that the area around the victim's chest had to be dug out before air could be forced into the lungs.

In Group 2 the man who had been carried through the trees was seriously injured, but no one was buried. In Group 1, the guide was shaken and one woman skier injured. Head counts were taken and all the skiers accounted for.

A doctor flown to the site determined that nothing could be done for the buried skier, who was later diagnosed to have died of suffocation. The body and the injured skiers were flown out to Valemount.

AVALANCHE

The avalanche was caused by deep slab instability. The snowpack contained depth hoar and crusts with some new snow at the top. The bed surface was, on the average, 70 cm below the surface and close to the ground.

The avalanche started at an altitude of 2260 m with a width of 300 m and on a slope of 38 deg, southeast aspect. A dry snow avalanche, it had a mixed flowing and powder motion and ran over 1000 m vertically. The deposited avalanche snow was widely scattered throughout the path and reached a maximum depth of 3 m.

COMMENT

It is often difficult to predict the stability of deep slabs, and in any case stability may change over short periods of time. On Friday the mountain was hospitable; on Sunday, after a relatively minor snowfall, it was not.

The accident reveals one of the problems of skiing in large groups when skiers are anxious to make new tracks in powder snow. The first skiers can choose relatively safe terrain, but the others often have to use the centre of an avalanche path in order to find untracked snow.

Once again avalanche rescue transceivers proved to be an excellent tool for rapidly locating a buried victim in a large avalanche. It is unfortunate that he was not found alive after so short a burial time.

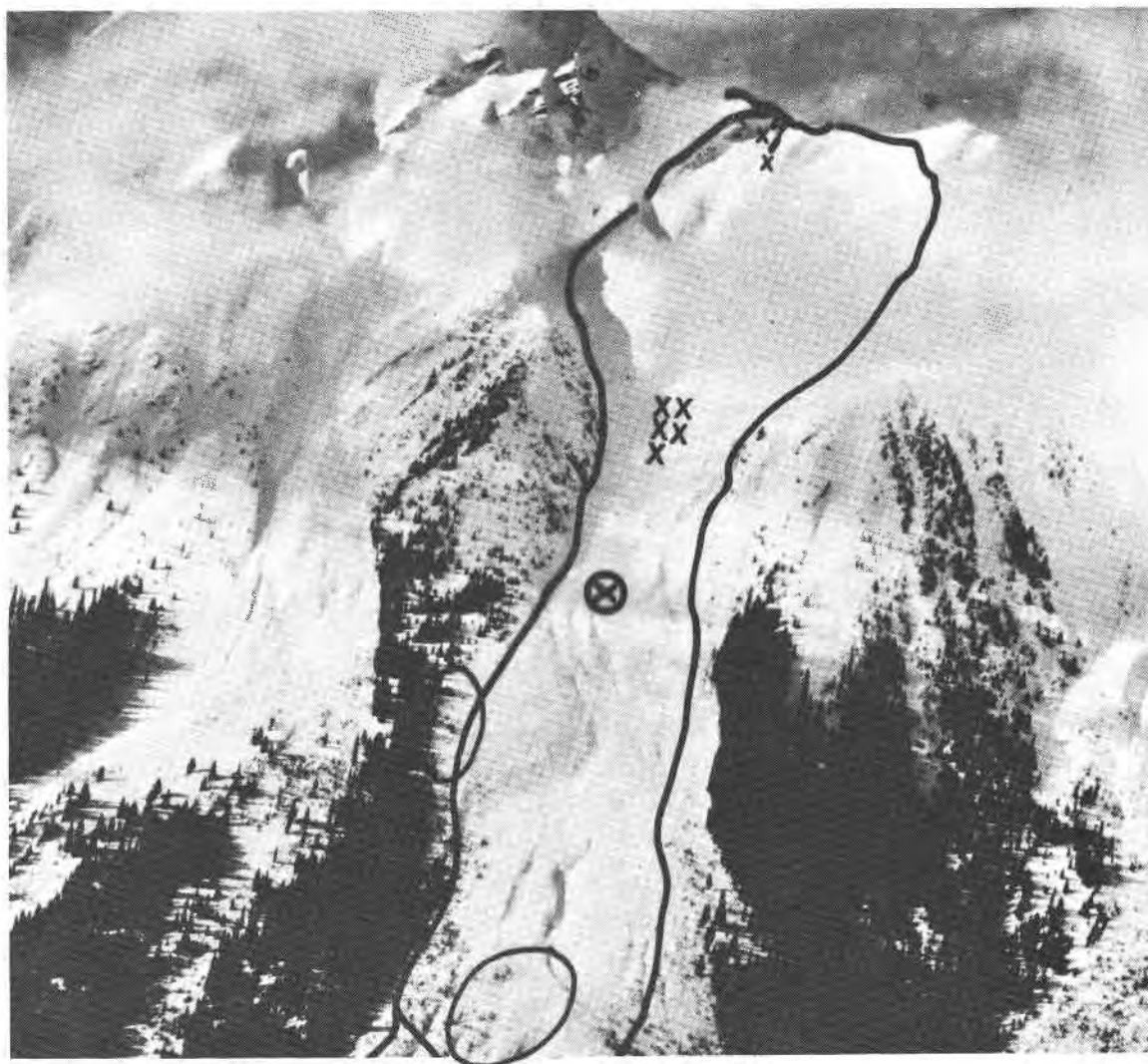


Figure 29 Avalanche path at Mica Mountain, 17 February 1974

- x Location of partially buried skiers
- ⊗ Location of victim

Circled areas indicate position of Groups 1 and 2
(Photo courtesy Canadian Mountain Holidays Ltd.)

One skier killed

WEATHER

The weather in the Sunshine area was clear with below-freezing temperatures prior to 30 March. Due to drifting, loose snow had accumulated on lee slopes. The snow in the area, however, was generally stable.

ACCIDENT SUMMARY

The victim was last seen by a skiing companion at the top of Brewster Chairlift between 1130 and 1200 h on 30 March. Later investigations indicated that the victim must have skied in a northwesterly direction along the bounding fence on the ridge of Lookout Mountain. At the end of the fence a natural rock obstruction diverts skiers back to the Angel run and the base station. The victim probably skirted the obstruction to go to the cliff in order to take photographs. He may have crossed the rocks and ventured out on a cornice, which broke and fell with him, starting an avalanche on the slope below.

RESCUE

Although the companion was unable to find his friend at the bottom of the ski run, he thought nothing of it. Even when the friend failed to return that night his companion thought perhaps he had met someone else and stayed out for the evening. On the following morning, however, 31 March, at about 1100 h he reported the missing person to the ski patrol. The patrol initiated a search of the ski area and at 1500 h made a report to the National Park Wardens.

A search on foot and by helicopter was immediately carried out over a wide area until dark with no results. At 0700 h on 1 April the search was recommenced, using dogs, personnel on skis and a helicopter. At 0900 h a party on skis and observers in the helicopter noticed two slides in the Delirium Dive area and further investigation revealed a broken cornice below the fence.

A follow-up party with two dogs was dispatched, arriving at the scene at 1310 h. One of the dogs immediately located a skipole. The search efforts continued for over 4 h but were suspended with the coming of darkness.

On 2 April at 0800 h the search was resumed, and at 1050 h the victim was found by a warden service dog. The body was in an inverted position, with the left boot 60 cm below the snow surface. The cause of death was determined to be suffocation.

AVALANCHE

The cornice probably broke under the weight of the victim and, in turn, released a small slab on the slope below. The cornice broke at an elevation of 2250 m and the ensuing avalanche had a vertical fall of about 140 m. The slope below the cornice has a northeast aspect and an average gradient of about 45 deg. The avalanche snow was deposited to a depth of about 3.5 m and was found to be extremely dense during the rescue.

COMMENT

The skier was a victim of lack of knowledge of the hazards in mountains. Common safety rules dictate not stepping on cornices because their stability is usually unpredictable. It is not surprising that the falling cornice released a slab avalanche below because deep, drifting snow usually has accumulated there, and the impact of the falling cornice would be strong enough to set this snow in motion.

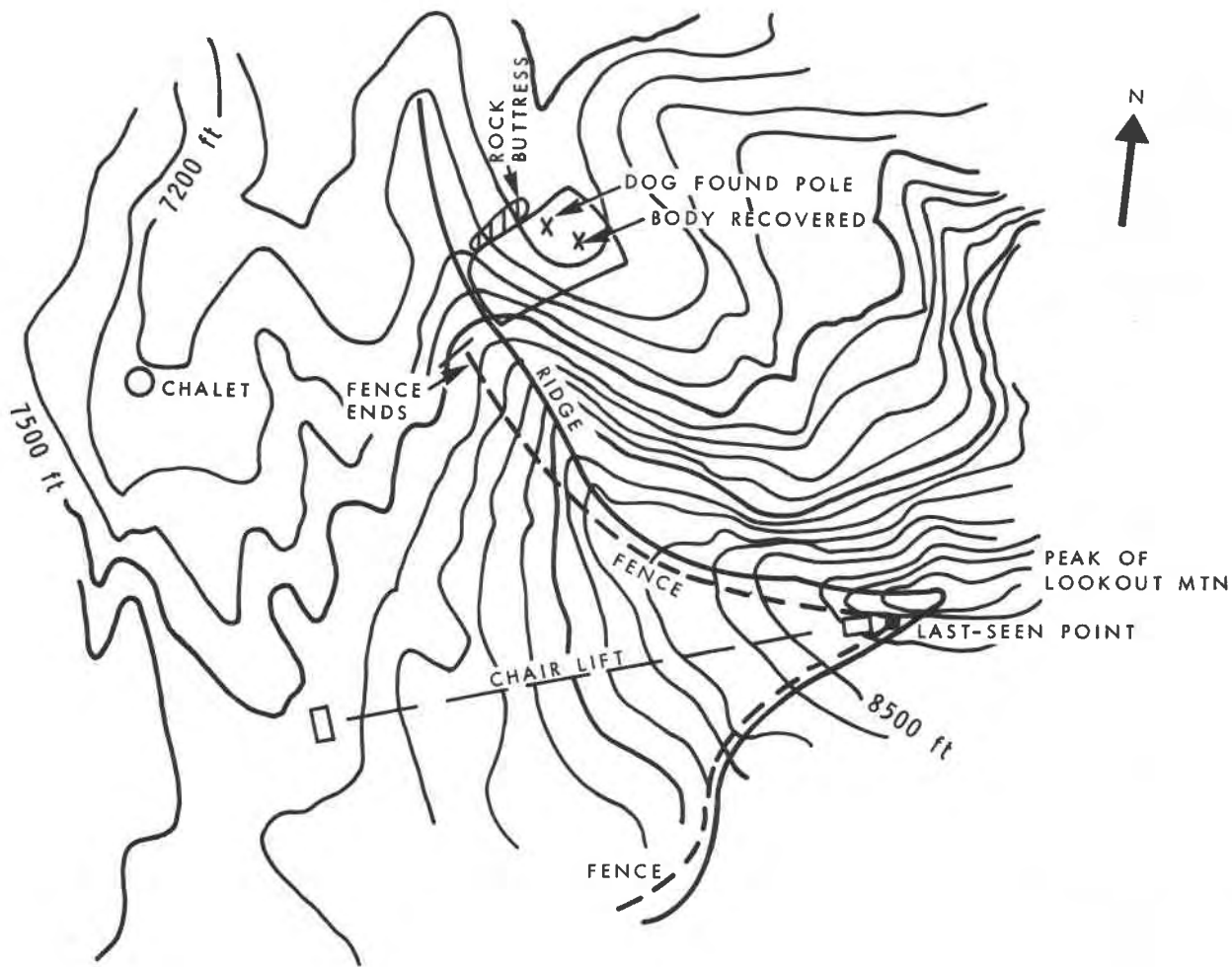


Figure 30(a) Contour map of Lookout Mountain, 30 March 1974.

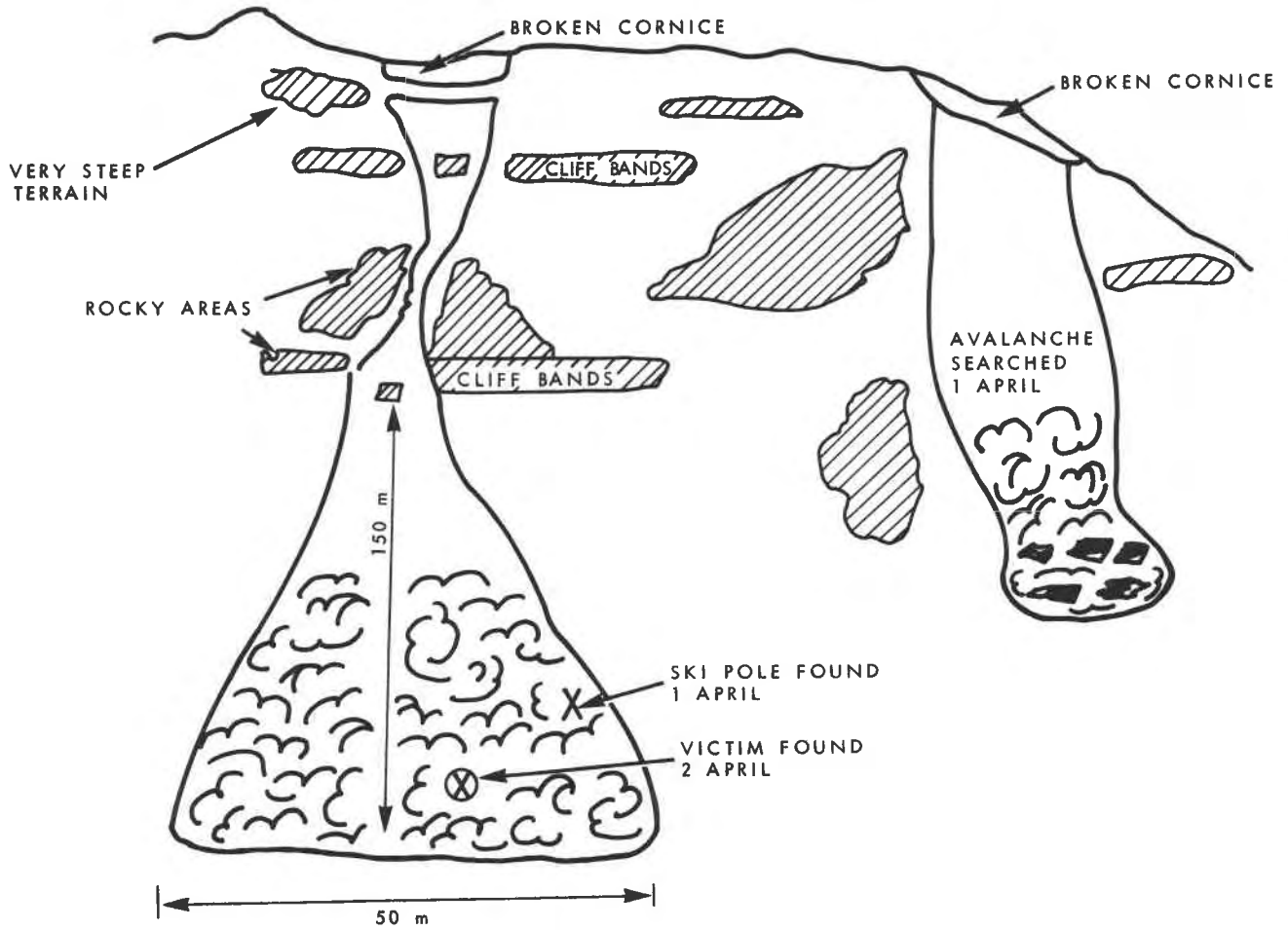


Figure 30(b) Sketch of avalanche path, Lookout Mountain, 30 March 1974.

Two skiers injured

WEATHER

Observation at Rossland MacLean Station, 1082 m ASL

Date	Temperature °C		Precipitation
	Max	Min	mm
9 March	2	-4	7.6
10 March	2	-3	3.8
11 March	3	-7	
12 March	0	-7	3.0
13 March	2	-6	
14 March	0	-5	8.1
15 March	0	-4	15.2
16 March	2	-3	5.3

For a few days previous to 16 March rain fell on Granite Mountain on a number of occasions and formed an ice layer on the lower mountain and a light crust on the upper mountain. Overnight, from 15 March to the early morning of the 16th, light, dry snow fell, becoming more moisture-laden through the morning of the 16th. By mid-morning over 30 cm of new snow had accumulated. Around noon on 16 March westerly winds with estimated speed 30-50 km/h were observed above the 1500 m level. Unsettled, cloudy weather prevailed in the early afternoon.

ACCIDENT SUMMARY

Granite Mountain was not open for skiing on 15 March. On 16 March, at approximately 1400 h, three skiers entered the steep chutes just above the Squaw Basin. Numerous chutes and glades exist in this area and a number of tracks had been laid prior to the passage of the party in question.

As the group skied down, a slab avalanche released and caught them. One woman was carried down through the narrow, steep chute and partially buried. She was severely injured, coming to rest against a tree. The second skier was struck by a windmilling ski during the avalanche and received facial lacerations, but was not buried. The third party member, a young girl, sustained an injured knee.

RESCUE

Because the party members were in varying states of injury and shock, the immediate rescue efforts were confused. The skier who had sustained facial injuries skied the traverse to the base station of the ski area where he reported the accident. The ski patrol then proceeded up the chairlift and to the accident site. Approximately 2 h after the accident the injured skiers were brought by oversnow vehicle to the base station.

COMMENT

The accident occurred in the same area as the fatal one on 23 December 1971. Although the Squaw Basin is beyond the ski area boundary, it is a popular powder skiing area. It is difficult to decide whether such areas, easily accessible from the lift terminal, should be closed to skiers, controlled, or marked with warning signs only. In any case, the ski patrol must be aware of hazardous conditions and be prepared for rescue in these areas outside the regular ski runs. Caches with rescue equipment should be maintained at the top of the lifts.

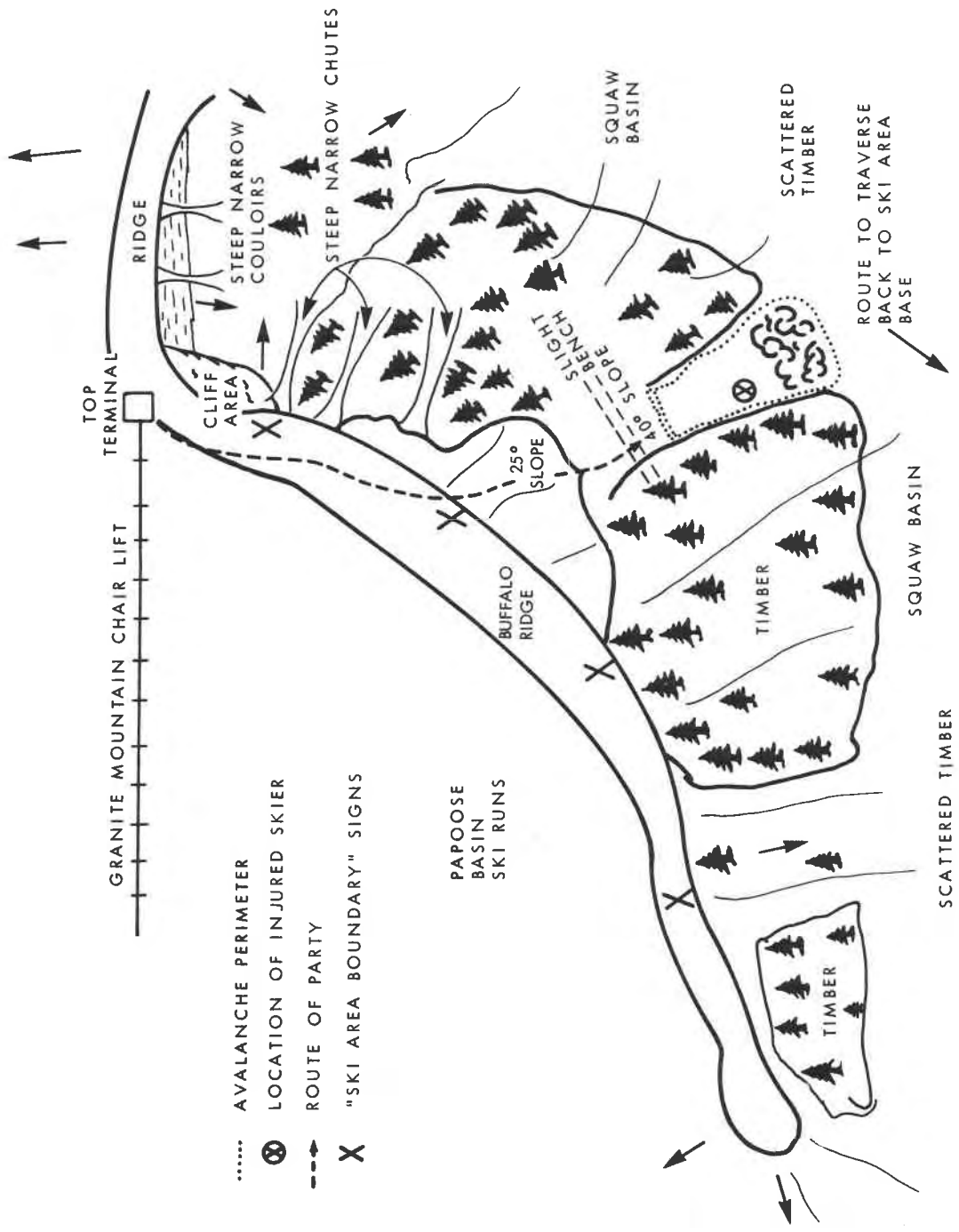


Figure 31 Sketch of avalanche area, Granite Mountain, 16 March 1975

One skier buried

WEATHER

Weather observations at the Rossland MacLean Station are listed under the accident at Granite Mountain on the same day. Red Mountain is just adjacent to Granite Mountain and experienced the same intermittent rains in the days prior to 16 March. A strong ice crust was formed on the lower mountain, covered by 30-35 cm of new snow.

ACCIDENT SUMMARY

At about 1600 h, 16 March, a party of six skiers decided to make the last run down the south side of Red Mountain. The area is permanently closed because of the hazard of deep mine pits, but it is often skied by locals. After descending through the mine pit area the group came to the last pitch, a smooth open mine talus slope above the road back to town. The group broke up to descend the untracked powder.

The first skier cut across the slope above a slight hollow at the lee side of a spit of trees, then turned down the fall-line, failing to notice that he had started a small avalanche. Overtaken by the moving snow, he was carried to the bottom of the slope and completely buried when the avalanche came to rest. Fortunately he was able to move one hand and to shake it free above the deposited avalanche snow.

RESCUE

The rest of the group skied immediately to the deposition area, discovered the single protruding hand and dug out their uninjured companion.

AVALANCHE DATA

The avalanche fractured to a depth of 40 cm and obviously contained dry new snow above the ice crust. It released at an altitude of approximately 1275 m and fell about 100 m vertically. The aspect of the slope is south and the gradient about 35 deg. The avalanche deposited loose snow with an average depth of about 1.6 m.

COMMENT

Experienced skiers, the group should have recognized the danger of the new snow overlying an ice crust, but as so often before the attraction of untracked powder prevailed. This skier was fortunate not to share injuries or worse with skiers caught in the avalanche at Granite Mountain 2 h earlier.

One tobogganer killed, one rescued unharmed

LOCATION

Cap Santé is 25 miles southwest of Québec City on the St. Lawrence River, and is 80 m above sea level.

WEATHER

Observations at Québec Airport, 74 m ASL

Date	Temperature °C		Precipitation
	Max	Min	mm
10 January	-18.5	-30	T
11 January	-19.5	-34	T
12 January	-16	-21.5	0.8
13 January	- 9.5	-21	2.3
14 January	- 4.5	-12	15.0

Heavy snowfall depositing 17 cm of new snow was followed by fine weather on the afternoon of 14 January.

ACCIDENT SUMMARY

Late in the afternoon two young boys were tobogganing on a steep, snow-covered hill near one of their homes in Cap Santé. It is believed that during a descent they were engulfed by moving snow and subsequently buried under several feet of it. The actual time of the occurrence is unknown as the accident was unobserved.

RESCUE

An extensive search was instituted by local police and citizenry at about 1700 h. After about 1 h the victims were discovered, buried under about 2 m of snow. One was rescued uninjured, but his companion was found unconscious and not breathing; all attempts to revive him were fruitless.

AVALANCHE DATA

The avalanche fell about 60 m vertically over a width of 7 to 10 m, depositing snow up to 3 m deep. The slope was considered to be quite steep and of southerly exposure.

COMMENT

Twenty years earlier the same type of accident occurred in exactly the same location. Although avalanches are rare in Eastern Canada, this and other accidents show that the possibility should not be discounted.

Three occupants of a vehicle killed, two rescued unharmed

WEATHER

Observations at Kootenay Pass, 1770 m ASL

Date	Time	Temperature °C		New Snow cm	Rain mm
		Max	Min		
12 January	0700	- 9	- 9.5	9	
	1600	- 8	- 9.5	5	
13 January	0700	- 8	-14	1	
	1600	-12	-15		
14 January	0700	- 8	-14	10	
	1600	- 5.5	- 8	6	
15 January	0700	- 3.5	- 6	20	
	1600	- 1.5	- 3.5	2	
16 January	0700	1	- 1.5	1	5 (approx)
	1600	3	1		

A light rain started at 2130 h on 15 January and the temperature reached 0°C at 0200 h on the 16th. Between 0200 and 0700 h and again at 1115 h on the 16th several small avalanches ran to the highway on the east side of Kootenay Pass, an area known for frequent small avalanches. The highway was closed intermittently, and opened at 1130 h.

ACCIDENT SUMMARY

Shortly before noon on 16 January five people were travelling west in a convertible car on Highway 3. Without warning, 2 km west of the summit of Kootenay Pass, an avalanche swept the moving vehicle from the road and carried it down the steep, long embankment. It came to rest against the first trees in the run-out zone, but the convertible offered little protection and all five were thrown out.

RESCUE

Another vehicle travelling in front of the convertible narrowly escaped the avalanche and continued westward. Encountering police, the driver reported the avalanche and his suspicion that one or more vehicles

following might have been caught. The police officer immediately proceeded to the site. At the same time another vehicle that had been following the buried car had stopped at the avalanche deposit on the road, turned back, and reported the accident at the highway maintenance establishment at the summit at about 1155 h.

Shortly after 1200 noon the rescue organized by the highway maintenance staff was under way. The first eight men at the accident site began probing the snow on the road. Fog did not permit a full assessment of the deposition area below the highway, but when more rescuers arrived two men walked down the steep slope for a search of the lower deposition area. One of them discovered a magazine lying on the snow near the toe of the most easterly deposit, and shortly afterwards, at approximately 1315 h, a leg was discovered protruding from the snow. The rescuers immediately dug out a young woman whose head was buried about 1 m below the surface. She was conscious and able to inform the rescuers of her four companions.

Additional personnel were called down from the highway. Random probing near the location of the first victim revealed a young child buried nearby under 1.2 m of snow. No signs of life were visible but after artificial respiration was administered the child recovered. At the same time, at approximately 1430 h, two other victims were discovered nearby, 0.6 to 1 m below the surface. Efforts at resuscitation were unsuccessful. At approximately 1500 h the last victim was found with her head approximately 1.6 m below the surface. Attempts at resuscitation were, however, unsuccessful. The two survivors were evacuated to Nelson by helicopter.

The remainder of the avalanche deposit was then checked for other vehicles and an R.C.M.P. dog searched for further victims.

AVALANCHE

The slab avalanche fractured 80 cm deep on a bed of an ice crust overlain by surface hoar (see Figure 33). The crust was the result of rain early in December, and the surface hoar had formed in clear weather between 5 and 15 December. Snowfall on 14 and 15 January, rain, and a high temperature probably triggered the deep unstable snow.

The avalanche started on an open, south-facing slope with an inclination of 40 deg at elevation 1825 m, about 200 m higher than the highway. Damage to trees and snow packed against them in the run-out zone demonstrated that the avalanche had a considerable dry powder component, but the snow deposited on the highway and below had a wet appearance and would point to a wet flowing component.

The avalanche had a total volume of 28 000 m³ of snow. It covered a 300 m length of highway with a depth up to 3.5 m.

COMMENTS

Deep weak layers in the snowcover such as crusts and surface hoar can produce unexpected, large avalanches. The ability to recognize deep instabilities through continuous observation of the snowcover makes the difference between an avalanche analyst and the casual snow and avalanche observer, but prediction of the time when an avalanche will start naturally as a result of a deep instability is difficult even for a skilled person. An unstable condition may prevail for several weeks without producing avalanches and rapidly change to critical with a snowfall, strong wind, or high temperatures.

The closure of a highway for long periods of time may be impossible when unstable snow conditions prevail, and it would therefore be necessary to control avalanches either by explosives or other means. Experience has shown that when a deep slab instability exists explosives must be applied repeatedly with variable charges, at different locations, and whenever the weather changes, until the unstable snow is removed in all the avalanche-starting zones. A full control program might have prevented the accident, but in the winter 1975-76 the avalanche control program at Kootenay Pass was limited owing to a shortage of artillery pieces and fixed gun emplacements.

Because the accident was observed, the avalanche site close to the highway maintenance establishment, and the maintenance staff trained and equipped for avalanche rescue, an organized search was initiated within a very short time. Unfortunately, fog and steep terrain delayed the search in the run-out zone below the highway, and this resulted in a long burial time for the victims. Both car and victims were found near trees, which again proved to be likely burial spots.

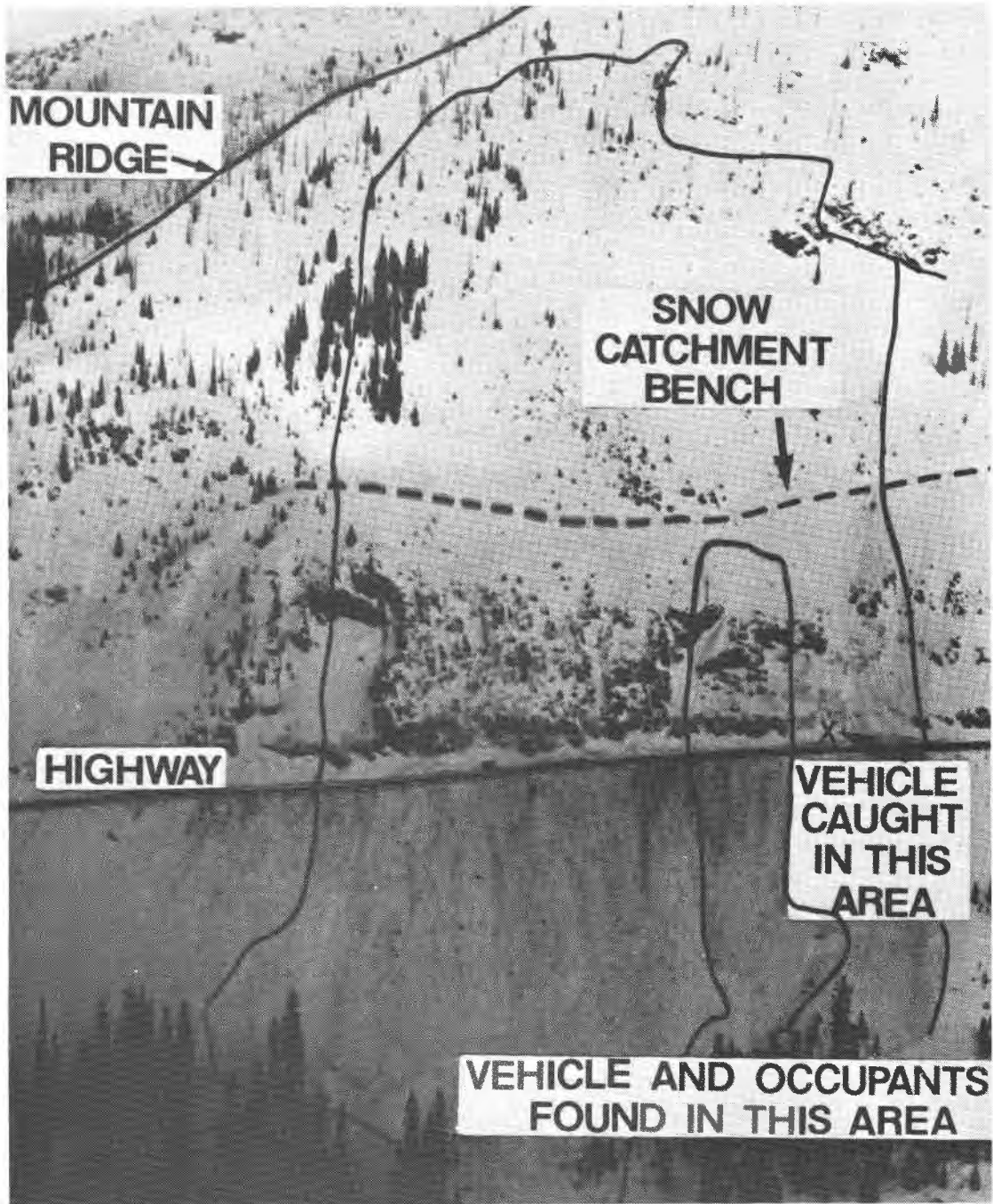


Figure 32 Avalanche site, Kootenay Pass, km 2 west, 16 January 1976
(Photo courtesy British Columbia Ministry of Highways and
Public Works)

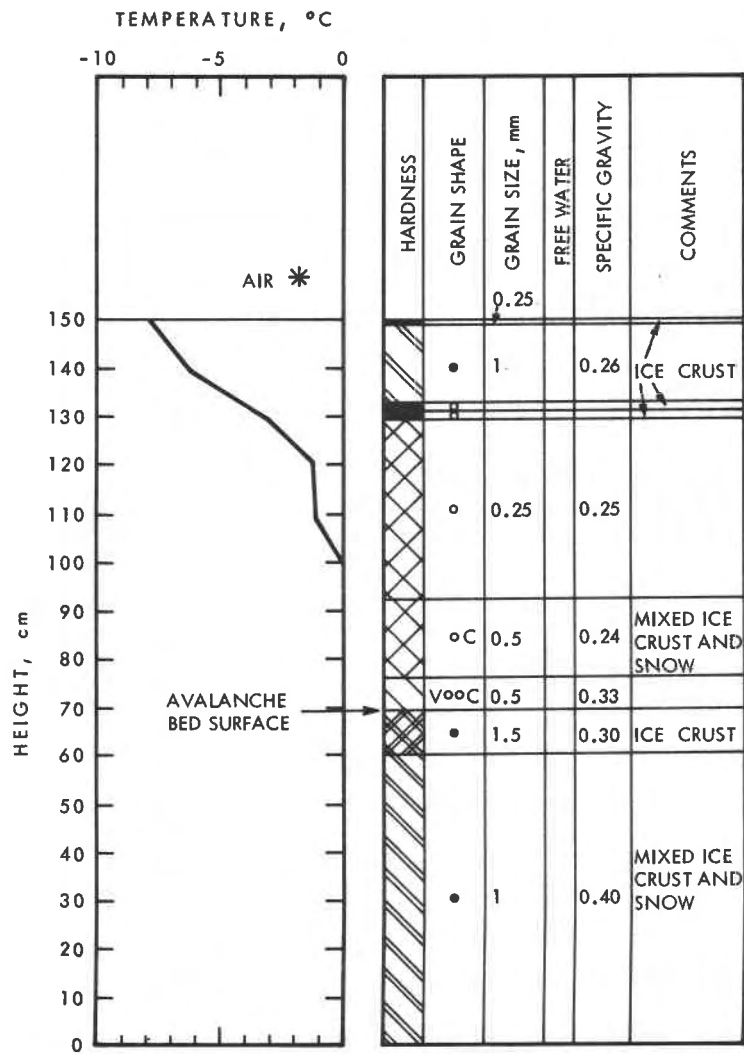


Figure 33 Snow profile at fracture line, Kootenay Pass, 19 January 1976.

One skier killed, two skiers injured

WEATHER

Tuesday, 23 March was a sunny day with light winds and a temperature of -5°C . No avalanche activity was noted in the area. Depth hoar had been observed throughout the winter in the eastern Purcell Mountains.

ACCIDENT SUMMARY

Two parties of nine, each with a guide, were skiing in Paradise Basin shortly after lunch on 23 March, each skier carrying an avalanche rescue transceiver. The groups had been flown to the summit by helicopter and the intended route from the landing area lay over the south ridge. Guide 1 took his party down a wind ridge to the east of the main slope, and after skiing most of the way they rested on a knoll near the bottom. Guide 2 skied down 15 or 20 m west of group 1, stopped and instructed his skiers to come down inside his track, two at a time. After the first pair had made a few turns and the second was starting the whole basin fractured. Guide 2 gave a warning over the radio to Guide 1 who saw the avalanche coming with two skiers being flipped through the steep rocky area in mid-slope.

RESCUE

When the avalanche stopped, Guide 1 instructed his party, who were untouched, to wait on the knoll while he climbed to two skiers he could see partly buried on the avalanche deposit.

He found the lower one injured, although not immediately endangered, and climbed quickly to the second skier who was also injured. In the meantime, Guide 2 had made a headcount and found a third skier missing. By radio he notified Guide 1, who immediately switched his rescue transceiver to receive and started to traverse down, picking up a signal within a couple of traverses.

As he was determining the exact point of burial, two other guides, who had observed the accident from the air, arrived with probes and shovels. The buried skier was located with a probe, his head was uncovered, and about 10 min from the time of the accident mouth-to-mouth respiration was started. Once the victim was freed from the snow a doctor from the ski group attempted cardiopulmonary resuscitation, but after about 20 min with negative results the doctor advised that there would be no point in continuing. It was later determined that the victim had died of head injuries. The two injured skiers were flown to the hospital in Invermere.

AVALANCHE

The avalanche released at an altitude of 2550 m, with a fracture line 60 cm deep running over 1000 m around the basin. The first skier, Guide 2, did not trigger the avalanche, and only the combined weight of several skiers started it. It ran on a south-facing slope of over 400 m vertical drop, with an incline in the starting zone of 28 deg increasing to 45 deg in the rocky area. This dry slab avalanche fractured on an internal layer and moved quickly over the surface. About 100 m from the top of the slope only a light snowcover was left. After the avalanche had occurred the debris was hard and firm by the time the body was freed.

COMMENT

The depth and strength of the snow pack varied greatly throughout the basin. The eastern side received wind-transported snow. Group 1 skied on the wind-exposed ridge and Group 2 in the area where drifting snow was deposited.

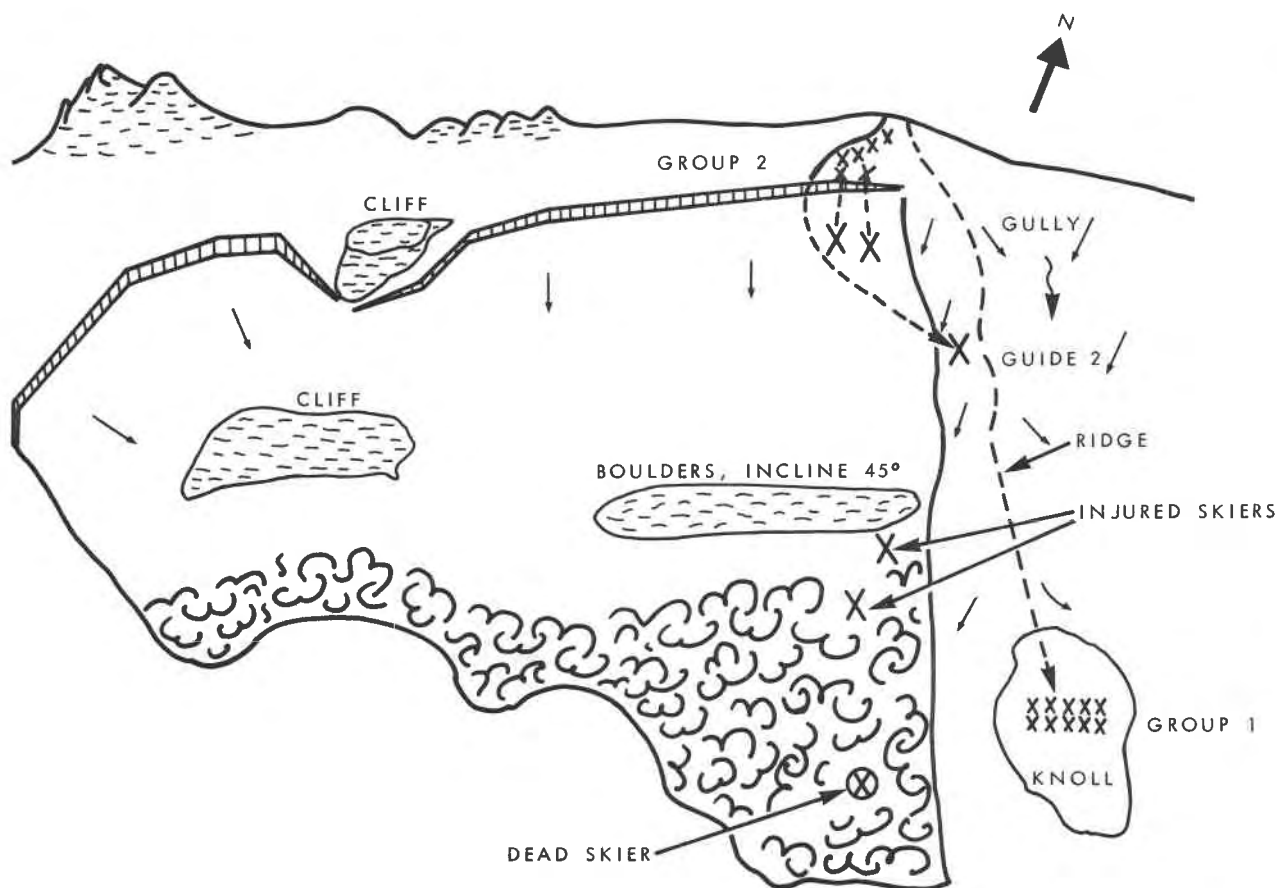


Figure 34 Sketch of avalanche at Paradise Basin, Invermere, B.C., 23 March 1976

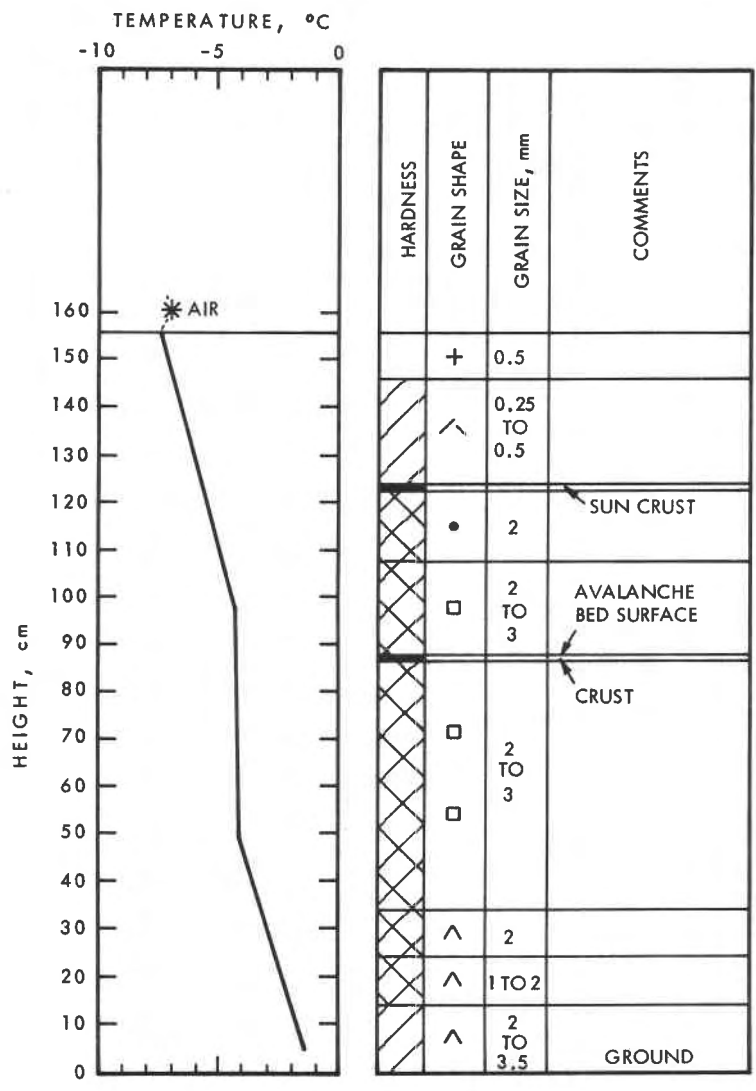


Figure 35 Snow profile at fracture line 50 m below the top, Paradise Basin, 24 March 1976.