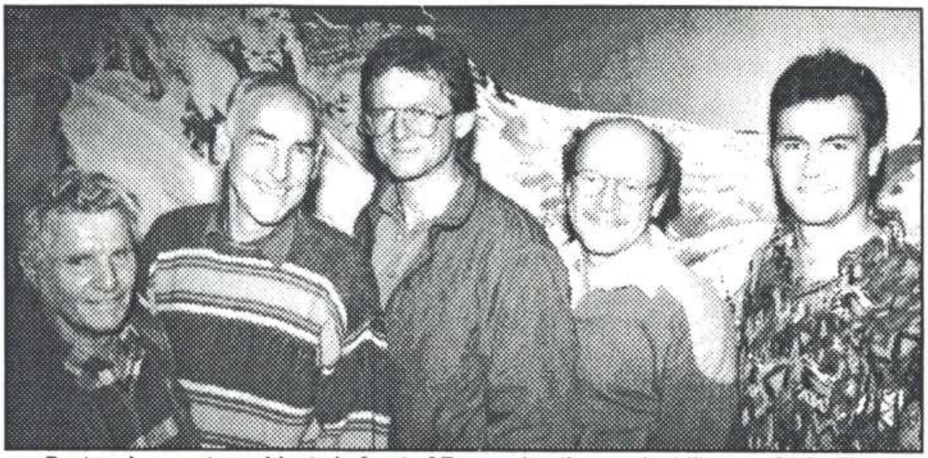
# Avalanche News

CANADIAN AVALANCHE ASSOCIATION

Number 49 — Summer 1996


# New CAC Office



Past and current presidents in front of Zuzana Isert's mural at the new CAC office.
L-R: Fred Schleiss, Peter Schaerer, Chris Stethem, Bruce Jamieson, Jack Bennetto.

The office of the Canadian Avalanche Centre has moved and so have some of the people.

After three winters managing INFOEX and playing a major role in completion of the new Observation *Guidelines & Recording Standards Book* Torsten Geldsetzer has moved back east of the continental divide. Last fall he counted nine times in November and December when he saw the sun briefly in Revelstoke. Two of those sightings were on one day weren't they Torsten?

Laura Howatt has left her position on the INFOEX to spend more time with her family and is working for the City of Revelstoke. Many thanks to you both and best wishes from the CAA Directors and Members, especially the INFOEX clients.

In the new office location at 300 - 1st Street West we are following the direction taken from the CAA Spring Meeting by reorganizing the work done at the Centre. Aileen White is now running the school registration with Phil Hein doing the course coordinator job. Aileen has spent 15 years with various RCMP offices so we are completely confident that she will get our CAA member files under control.

Aileen has an interesting avalanche story. In February 1976 her nephew Teddy, age six, was buried by an avalanche while playing on the piles of snow near his house in Revelstoke. A search started for the boy but he was not found for several hours until the neighbour dog, Baggins, was brought to the scene and found him. Baggins received a national award (?first live avalanche recovery by a dog in Canada?) and Teddy now works as an underground electrician. Crystal Mathews has taken on the bookkeeping and Sally Thomson is helping out with fund raising work.

The new office has a splendid mural done by CARDA member Zuzana Isert. The scene on the wall facing the entrance shows the view from across Abbott Ridge up the Illecillewaet from Uto towards Youngs Peak. The art and photography work of other CAA members is also on display, thanks Roger Laurilla, Bruce Kay and Diny Harrison. At the official office opening a photograph was taken by Mas Matsushita of the five CAA presidents in front of the office mural. It is shown on the front cover of this issue and is available for sale (8 X 10 black & white) by donation to the CAC. Thank you.

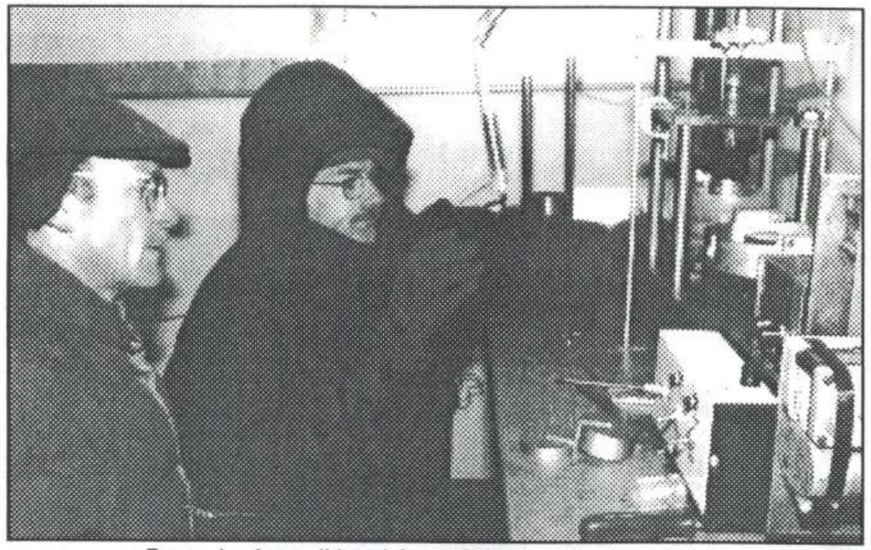
Inside

# Canadian Avalanche Centre

## REPORT ON THE WINTER OF 1995 - 96

by Alan Dennis

For many years Peter Schaerer wrote the winter Snow & Avalanche Summary for the summer issue of the Avalanche News. It was a piece that I always enjoyed reading in the Yukon summer or New Zealand winter and helped put the previous season into perspective. Written in Peter's inimitable style and with his attention to technical detail they are classics if you have a look back through the older issues of the Avalanche News. Since 1991 it has been a tough act to follow and with this issue I chose to write a more subjective commentary.



Bruce Jamieson (L) and Juerg Schweitzer in the cold lab.

The 1995-96 snowpack ranged from a 33 year record in the Columbia Mountains, to a huge snowpack season in the Rockies and an average snowpack for most of the Coast Range. In the past 20 years most accidents occurred in the triangle between Fernie BC, Jasper and Vancouver Island. This is where the greatest concentration of people and avalanches are. As we have seen (p 18) in this year's accident report, the exceptions to any rule are shown well this winter, with fatal accidents in the high arctic, remote parts of the BC coast and mine tailings piles in Quebec.

But back in the Canadian Avalanche Triangle where a 33 year old record was broken. On January 15 at Rogers Pass the height of snowpack exceeded any previously recorded value. Unfortunately, it was a record that lasted for only a day. Overall, the Columbias snowpack was much deeper than average and this was caused by a cold and early start to the season which produced significant snowfalls through November and December. There were buried surface hoar layers that were monitored closely. Generally they seemed to gain some strength quite quickly, although the 28 December layer was still recognizable in tests in mid-February.

The Rockies enjoyed an unusually deep and strong snowpack while the Coast Range from Garibaldi to the Yukon was near average for the amount of snow that fell. All regions had a late spring with winter snowpack conditions persisting into May in the higher alpine terrain. Even on the July holiday weekend cold snow conditions and avalanches were reported in the Wapta Icefield.

In the Rockies, the largest avalanches were the result of direct action during or immediately after the storms. Ask Reg Bunyan who, after many years working avalanche programs in other National Parks, received a hearty welcome to Kootenay Park. He triggered huge avalanches with the new control program 106mm Recoilless Rifle, many hectares of forest were destroyed but the road was open when safe. He thinks he has recovered from the experience and looks forward to next winter. The old hands on the Banff Jasper Highway got a marvellous reminder of the forces of nature. Avalanches larger than any of them could recall responded in uncharacteristic fashion with their size, ferocity and timing. Large avalanches outside of storm cycles were uncommon, except for the usual icefall triggers.

During one of the large avalanche cycles at Rogers Pass, the CAA level 2 course that was running at the time had much difficulty getting out of the hotel. And for the first time since the INFOEX has been operating there was one day this winter when no commercial back country operation from Valemount to Cranbrook was able to ski. This interruption of operation was due to a combination of poor stability, poor visibility, rain and irregular layers of cold and warm air near surface.

On an operational level there were few changes in the numbers and types of avalanche safety programs. The depressed mining situation in British Columbia means there is little avalanche work going on in developing mine properties. There were some interesting avalanche occurrences in forestry cut blocks. These received more attention than in the past as it is recognized that the effects of this damage is preventible and causes extensive economic loss. The new ski area addition to Sunshine Ski area presented an additional challenge to the avalanche forecast team



there. It is reported elsewhere in this issue about the introduction of GAZEX to the Kootenay Pass avalanche program.

Avalanche research continued during the winter. Bruce Jamieson and Colin Johnston from the University of Calgary with the BC Helicopter and Snowcat Skiing Association are now in their ninth year of continued efforts to unravel the mysteries of persistent snowpack instabilities. The mystery continues but some of the field tests developed are helping to reduce the risk. At the University of British Columbia Dave McClung and his avalanche research group are applying their research to forestry, highways and human perception issues. Mountain Watch Inc., a Calgary based company, completed another winter of data gathering and equipment testing in order to study creep/glide and the timing of avalanche release.

In Banff Park, (led by Tim Auger, one of the old hands) research was done into probing avalanches with techniques that may give a better chance of live recovery and reduce exposure time for the rescue team. The results of this research will be presented at the ISSW and allow good opportunity for the debate at the socratic level and on a social beverage level (no hemlock allowed). The photo shows Juerg Schweizer and Bruce Jamieson working in the cold lab at Rogers Pass. Juerg spent the winter doing research based at the Pass on an exchange fellowship from Davos. He and Coni also did most of the ski tours in the region that many folks take five years to do. The results of Juerg's research will be presented at the ISSW in Banff

Every recreational activity in the mountains continues to experience unprecedented growth. Accurate numbers are not available but two indicators confirm the observation. Sales of all equipment is increasing especially snowboards and snowmobiles. Also, the parking lots and huts are full and the "secret" bowl that you swore all your friends to secrecy about is already tracked out by the time you get there. The Public Safety Services of the Canadian Avalanche Centre contribute to reducing the risk for recreational users and some graphs show the growth in use of the Avalanche Bulletin.

All the sponsors and partners involved with this project are shown in this issue but special thanks for their efforts is offered to Jennifer Clarke and her employer Summit Environmental Consultants who helped bring the Bulletins to a wider audience through the Cyberspace Snow and Avalanche Centre. The western provincial snowmobile associations have been very active in promoting avalanche safety especially Darcy Svederus of the Alberta Snowmobile Association and Debbie Paynton of the BC Snowmobile Federation.

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Chris Stethem & Associates
SNOW SAFETY SERVICES
P.O. Box 1507
Canmore, AB, T0L 0M0
Phone: 403-678-2477 Fax: 403-678-3486
Canmore AB   Whistler BC   Terrace BC

April 01, 1996

Dear Fellow Avalanche Workers:

ISSW '96 is coming to Banff, Alberta, Canada next October. I'm writing this letter to underline how good these workshops can be and invite you all for a visit to the magical terrain of the Canadian Rockies There aren't very many workshops of one day duration of $125 (US$90), let alone a four day workshop where you can meet a large chunk of the people who work in your profession.

It will be 20 years since the 1976 Banff workshop on Avalanche Control, Forecasting and Safety. At that workshop there were 129 participants, mostly from Canada and the U.S., with 3 participants from Japan and Norway. In 1976, Ron Perla brought together avalanche control personnel and snow scientists from far and wide. He convinced many of us that yes we could in fact write a paper and then stand up and talk about what we did in our work, whether it was avalanche control, safety operations, forecasting or research.

But the most important part of that 1976 workshop, at least for myself, was the contacts I made, many of whom still work in this business and have become close friends. I have read a variety of opinion lately where the writers are trying to define what an ISSW should be or perhaps to save what they truly believe is the essence of the workshop.

The essence of the workshop is the people who are there. The thrust of the papers are the thoughts and work of those who come forward to speak. The topics of the 1996 workshop are wide ranging. You can present a paper on the problems of avalanche protection along ski area boundaries or in backcountry heli-ski operations. You can discuss your recent work in forecasting or avalanche dynamics. Personally, I'm very interested in hearing from both the practitioners and the scientific community - the merging of theory and practice.

And if you have seen something truly amazing, there's nothing like a good story. So come to Banff. Meet the people in your field. Argue the meaning of snow over a Canadian Beer.

If you need help to write or edit your work contact the ISSW '96 committee.

See you there,
Chris Stethem
ISSW '96 Organizing Committee

## Dominic Neuhaus

Dominic Neuhaus died suddenly of a heart attack on the afternoon of June 17th at his home in Kamloops. Manager of Canadian Mountain Holidays Monashee Heliskiing operation in Mica Creek since 1980, Dominic took his guides training in his home country of Switzerland.

Dominic was born March 27, 1945, in the village of Neuhaus-Plasselb, Switzerland, and first came to Canada in 1970. Working his early years in Canada in ranching, and then logging, Dominic naturally came to the hills in winter to ski and first worked in the Canadian ski industry at Todd Mountain. He returned to Switzerland to train as a mountain guide and completed his international certification in 1975.

He began heliski guiding with CMH the following winter, working for several years mainly in Radium and Valemount, until becoming manager of the CMH Monashees in 1980. Dominic maintained his status over the years as one of the less obtrusive members of the CAA.

Dominic was well known for his low key manner and easy going nature. Steady and observant however, his years of guiding and managing one of heliskiing's premier operations, was met by one of the best records of safety and service to skiing guests. Truly unique as an individual in the profession, Dominic will be missed both by his colleagues as well as the many guests who shared his passion for the snow covered hills.

Dominic is survived by his friend and companion, Ilene Logan of Kamloops, his mother, two brothers, three sisters, and many of their offspring all of Switzerland. He maintained close ties with his family, returning several summers in recent years to guide in the Alps.

The CAA recognizes the solid contribution Dominic Neuhaus made to the safety of skiers from hazards in the mountains, particularly from the threat of avalanches. We extend our sincere regrets to Ilene, his family, and to all of Dominic's friends.

## Beating the Odds

The CAA's new video avalanche awareness and rescue is now available. Shot on location in the Cariboo Mountains, this educational drama tells the story of people who play and work in avalanche terrain. When trouble strikes, some are able to look after themselves but others need the help of their friends and the pros.

The 48 minute production demonstrates awareness, promotes education, and entertains. It is ideal for groups and individuals involved in snowmobiling, skiing/boarding, and SAR. It will be especially useful in avalanche awarenss courses and group or club gatherings where you want to sprad the gospel of avalanche awareness message in an entertaining and interesting way. It's sure to attract attention and promote discussion! Get your copy today.

The video is available for $29.95 + taxes + Shipping and Handling from Yak Alpine Enterprises in Calgary (see box.) **Proceeds from sales support the Public Safety Services of the Canadian Avalanche Centre.**



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Publisher: Jack Bennetto
Manager, Snow Avalanche Programs
Ministry of Transportation & Highways
940 Blanshard Street
Victoria, BC, Canada, V8W 3E6
604-387-6931

Design: Karl Klassen
Text and Image
188 Bow Green Crescent NW
Calgary, AB, Canada
403-288-3072

Next Deadline: October 15, 1996

Managing Editor: Alan Dennis
Associate Editor: Dan Nixon
Canadian Avalanche Centre
Box 2759
Revelstoke, BC, Canada, V0E 2S0
604-837-2435

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• Double spaced, typewritten
• Major PC wordprocessor format
• Photos, slides, or illustrations
• PC TIF, WMF, CGM format
• **Always send hardcopy**



# Avalanche Involvements in Canada - 1995/96

by Torsten Geldsetzer

There were five fatalities in Canada during this past winter. That statistic is the lowest since 1984 and, of those five fatalities, only two were in western Canada. In all, we had 64 reported avalanche accidents involving 88 people. One-third of all these accidents occurred during the avalanche cycle during mid to late January.

From the reports we received: 57 of the people involved were backcountry skiers; three were skiing inside a ski area, (avalanche control personnel),; 7 out-of-bound skiers, four out-of- bounds snowboarders; one snowmobiler; eight climbers; and eight were involved in a variety of other activities. Obviously, there were more involvements! A lack of reporting only heightens the goal of the CAC to increase awareness and educate the public as to the importance of reporting avalanche involvements especially among our newest member groups, snowboarders and snowmobilers.

Geographically, 13 accidents were reported on the coast, 26 in Interior BC, 21 in the Rockies and four in other parts of Canada.

To further describe these involvement's: 14 people were reported completely buried. Of these, three resulted in fatalities. There were three methods by which these people were located: nine by transceiver, one by visual observation under the snow, and one by locating a ski swinging through the snow! Two of the fatalities were partial burials All five fatalities were located by probing.

The stability of the snowpack of the Rockies contributed to a lower number of serious accidents this past winter. The CAC would also like to attribute increased public awareness of avalanche danger.

The following are brief descriptions of the fatalities occurring this past winter.

### Baffin Island NWT

On November 12th, a snowmobiler was caught in a size 3 avalanche, completely buried and subsequently died. Few details are known about this accident save to say the nearby community executed a well organized rescue attempt.

### Robertson PQ

On December 22nd, two skiers died in an avalanche near Robertson, PQ. They were walking, skis on their back, up a tailing pile about 130 m high from an abandoned asbestos mine. The slide was described as being a moist, loose snow run out to the ground level. A search was initiated when they were reported overdue. A party of 30 rescuers probed the deposit with sticks and poles. Both victims were located under 1m of snow 6 hours after the slice occurred.

### Stagleap Park BC

On January 4th, a group two snowboarders and two skiers were carving the slopes in Stagleap Provincial Park near Kootenay Pass. One of the members was not feeling well and decided to return to the trailhead alone. While snowshoeing across a steep slope with his snowboard on his back, he was caught in a size 2 avalanche that buried him with only his hand in sight. One of the other group members followed the victim's route later and came across the slide area. He saw the hand at the snow surface and dug out the victim who had been buried for 45 minutes.

### Kokanee Provincial Park BC

On February 26th, the hut attendant at Slocan Chief cabin left with a group of new skiers to show them the route up Smugglers Ridge. Near the top, he left the group to ski alone down to Kokanee Pass to meet some friends. On his way down, he skied over a steep convex roll and initiated a size 2 avalanche. He was carried through a small stand of mature timber and then carried on down the slope. He came to rest at the end of the deposit with only his hand exposed. He was not reported missing until 9 hours later and he was located by 11:45 pm that evening.

### Bella Coola BC

On May 17th, three people died while ascending the west face of Mt. Cerebrus as part of a three week ski touring trip in the Monarch Icefield area. Several of the group members were experienced and had participated in numerous extended trips. While the group was prudent in their use of avalanche safety equipment, route choice, and avalanche assessment techniques, they underestimated the effect of unusually wintry spring snow pack of 1996 and the four days preceding the accident which were unstable, stormy and cool. The three skiers were swept approximately 200-300 m over an ice fall and down to a basin below. Two group members had decided that the risk of the ascent was beyond their comfort level and were nearby and able to respond quickly locating the three victims within 20 minutes of the slide occurring. They left the bodies partially buried and retreated from the area as they were concerned for their own safety and felt there was nothing further they could do.

# The "Terminology Salad"

## ...from the snow stability rating system to the avalanche danger scale...

by Walter Bruns

| Danger Level<br>*Colour*<br>—WHAT— | Avalanche Probability<br>*Trigger Size*<br>—WHY— | Recommended Action<br><br>—WHAT TO DO— |
|---|---|---|
| LOW<br><br>GREEN | Natural slab avalanches highly unlikely; human triggered releases unlikely; sluffs possible. | Travel is generally safe; normal caution advised. |
| MODERATE<br><br>YELLOW | Natural slab avalanches unlikely; loose or human triggered slab avalanches possible. | Use caution in steeper terrain on certain aspects. |
| CONSIDERABLE<br><br>ORANGE | Natural or loose avalanches possible; human triggered slabs probable. | Use increasing caution. Be aware of potentially dangerous areas. |
| HIGH<br><br>RED | Natural and human triggered slab or loose avalanches likely. | Travel in avalanche terrain not recommended; safest travel on windward ridges or lower angle slopes without steeper terrain above. |
| EXTREME<br><br>RED with BLACK BORDER | Numerous natural avalanches certain and slabs easily triggered by humans. | Travel in and near avalanche terrain should be avoided; travel only in low angle terrain well away from avalanche path runouts |

We are now using a revised snow stability rating system [1] and the new avalanche danger scale shown above. Many in the avalanche community have wrestled with these developments for some time, agonizing over the exact wordings. Some have also experienced indigestion from the ensuing "terminology salad" [2].

Peoples' understanding of the rating system or danger scale will vary as their interpretation of such probabilistic terms as: mostly, marginal, very, can be expected, possible, probable, (un)likely, may, isolated, specific, certain, etc. Of great interest — or concern, depending — are the recommended actions included with the new avalanche danger scale. The merging of Canadian and American danger scales has evidently encompassed recommendations as found in the European scales.

This article will toss the "terminology salad" yet once again, in an attempt to rationalize concepts and critically examine what we are trying to accomplish.

### Relationships

The data required for judgment of avalanche danger can be broadly categorized into three classes of factors [3]. Meteorological factors are measurable, numerical observations. Snowpack factors are largely qualitative observations of snowpack structure. Stability factors are mostly objective and subjective observations of snow mechanics. There is a forecasting sequence of class III → II → I following the chain of causation of avalanche events, with a decreasing number of factors in each successive class and a corresponding decrease in uncertainty [4]. The relevance of the factors in each successive class to the actual judgment of



danger increases. This can be summarized in tabular form:

| Class / Data | Nature | Relevance |
|---|---|---|
| III / Meteorological factors | Quantitative | Indirect |
| II / Snowpack factors | Qualitative | Semi-direct |
| I / Stability factors | Objective/Subjective | Direct |

**Table 1**

There is a general correspondence between the classes of data and the space/time domain over which the data applies [5]. Domain can be quantized by overall scale, specific resolution of extent, and timeframe. The correspondence is illustrated by overlaying table 1 onto table 2 and relating the cells:

| Scale | Resolution | Timeframe |
|---|---|---|
| Synoptic | Mountain Range | Future |
| Meso | Drainage/path/run | Near-future |
| Micro | Single slope | Present |

**Table 2**

Any determination of broad categories and general correspondences will be at the expense of sub-structure and subtler relationships. There is clearly some overlap among factors, and there exists a continuum of observability, relevance and domain.

Now consider the thought processes that take the classes of data and apply them to the domain, in order to arrive at a judgment of avalanche danger. There is a cognitive sequence of:

**Information → Knowledge → Wisdom [6].**

The word information here represents raw data (signals) before processing. The acquisition and dissemination of information occurs over the entire domain, for all classes of data. Knowledge resides in individuals or groups of people on the basis of their skills, experience, training and education with the given information. Information does not automatically give rise to knowledge. Wisdom represents the final state of understanding what is true. Wisdom does not necessarily follow from knowledge, either. Good judgment requires wisdom.

Table 3 categorizes the sources of information, the people that process it, and the state of understanding which they arrive at, in a format consistent with the first two tables:

| Information | Knowledge | Wisdom |
|---|---|---|
| Advisories/bulletins (AES, CAC) | All avalanche people | General overview |
| Internal/operational/CAC INFOEX | Groups/agencies/operators/teams | Action plans |
| In-field/on-site | Teams/individuals | 'Go/no-go' decisions |

**Table 3**

### Processes

With headings omitted, picture a 3x3x3 cube by overlaying tables 1, 2 and 3. 'Decision stuff', if you will, flows through the 27 cells roughly from left to right columns, upper to lower rows, and top to bottom through the cube by a myriad of paths. The process minimizes uncertainty (and maximizes certainty) to arrive at the proverbial bottom line of a 'go/no-go' decision.

The conventional process of avalanche forecasting is such a flow pattern. It synthesizes some deductive logic with mostly inductive logic in a (mostly) scientific method. An iterative procedure employs redundancies to minimize uncertainty [4]. These are like vortices and eddies in the flow of 'decision stuff' through the cube. The process is overlaid on the terrain, as selected by scale, resolution, and the desired timeframe. The limiting case of a forecast for the future is a 'nowcast' at the present.

Numerical or statistical prediction systems [7] apply more over the upper rows of the cube. That is, analysis of mostly class III data over the synoptic scale yields a quantitative, general forecast with indirect relevance over entire mountain ranges which targets many people. Rule or knowledge based expert systems (artificial intelligence) [8] apply more over the middle rows. In other words, analysis of mostly snowpack factors via qualitative rules by groups of specialists will yield semi-relevant forecasts and area-specific action plans over the meso scale for the group concerned. These systems will not directly apply to individuals facing on-site, right-now, 'go/no-go' decisions; that would be a stretch of their domain of validity.

### The Salad

Now back to the stability rating system and avalanche danger scale. One must ask what the purpose of the exercise is. Who wants what, where, when and why? There is everyone from the general public to specific interest groups to individual decision makers. These people want anything from a general overview to specific plans or real-time decisions. They need these for entire ranges, certain drainages or individual slopes. They need them to plan in advance, at point of departure, or on-site. The only common point is "why?". Everyone, eventually, needs to decide whether to go or not to go.

The snow stability rating scale represents a summary of subjective *estimations* of class I stability factors. *Estimation* is used rather than *evaluation* because we are dealing with "judgment based on rather rough calculation" [9] rather than setting a value on something. The domain of validity of the rating scale extends over the lower rows of tables 1, 2 and 3. It is most relevant to a real-time 'go/no-go' decision by on-site individuals over the micro scale of terrain slope by slope. You will have a hard time getting a numerical, statistical or expert system to give you a meaningful snow stability rating for a single slope. You will have a hard time meaningfully applying a snow stability rating to a larger extent of terrain (even though we attempt to do it every working day in the field)! The rating scale is one of many tools to shape the flow of 'decision stuff' through the lower rows. As such, a snow stability rating is exchanged among specialist groups in similar situations, and then as one of a number of pieces of processed information (knowledge). Probabilistic terms are generally understood within the context of common usage.

The avalanche *danger* scale **ought** to be a tool to shape the flow of 'decision stuff' through the upper rows. *Danger* (not *hazard*) is the proper term for this scale because it is "the least specific" [9]. Class III data can be synthesized to a longer term forecast for entire mountain ranges and disseminated by bulletin to interested parties **to provide a general overview**. But can it be taken further than that? Here is where previous attempts have foundered. Once snowpack factors become inputs and unstable slabs are discussed, we are into class II data. Relating their location to certain aspects takes us to the meso scale. Assessing the probability of unstable slabs as a function of slope angle implies class I data on the micro scale. So does any reference to natural or human-triggered avalanche activity. Finally, and most crucially, any scale of recommended action —WHAT TO DO— takes us directly to specific plans and 'go/no-go' decisions . Probabilistic terms within the scale are wide open to interpretation.

The avalanche danger scale **could** address the meso/micro scale given a sufficiently complete class II/class I database and enough processed information. It would need to become area and time specific over the appropriate domain. Trouble is, to do so requires that qualitative, objective and subjective estimations on the part of an increasing number of knowledgeable individuals enter the process. It then ends up becoming an expert opinion poll. Do we want non-experts to govern themselves on the strength of these opinions?

## Suggestions

The snow stability rating system is one of many tools to facilitate "information exchange between the wide variety of avalanche safety programs in Canada" [1]. This is achieved very nicely within the INFOEX framework. The avalanche danger scale was to conform with international efforts towards a standardized format for "advising about avalanche conditions in a variety of languages for people who go into the mountains in different countries" [2]. It seems that in the latter, well-intentioned effort to be as helpful as we can to as many people as possible, we are stepping beyond the domain of validity of what we set out to do.

The overarching goal is increased safety for all persons exposed to the possibility of avalanches. Through its courses and published materials, the CAC continues to make a significant contribution. The question here is, to what extent does the CAC want to use an avalanche danger scale to offer the public just information, to share some knowledge, or actually to try and impart some wisdom **by such means**?

I would suggest that, for day to day purposes in the public domain, we restrict ourselves to the conveyance of information only. I would be very hesitant to convey knowledge to those whose own level of knowledge is unknown, and generally less. I am strongly opposed to any recommended actions being included in the avalanche danger scale.

Let the people that would use the additional information supplied by the CAC apply **their own** knowledge to reason through to understanding, and make **their own** decisions on that basis.

## References

[1] CAA Observation Guidelines and Recording Standards, May 1995, appendix H
[2] Avalanche News Number 44, Fall 1994, page 1
[3] McClung and Schaerer, 1993. The Avalanche Hand book, chapters 6 and 7
[4] LaChapelle, E.R. 1980. The fundamental processes in conventional avalanche forecasting. Journal of Glaciology 26(94): 75-84
[5] Dave McClung, presentation to CMH guides' training session, December 1994
[6] "In praise of knowledge", The Economist May 27 1995, page 20
[7] Weir and McClung, Avalanche News Number 43, Summer 1994, page 2
[8] Weir and McClung, Avalanche News Number 42, Winter 1993/94, page 2
[9] The American Heritage Dictionary of the English Language, 4th printing, 1970

# 1995/96 INFO EX REPORT

by Torsten Geldsetzer

It was another successful season for the InfoEx. We had 50 subscribers, an increase from 49 last winter. We welcome Cat Powder Skiing Inc., Evans Forest Products Ltd., and Retallack Alpine Adventures as new subscribers.

The InfoEx made a small profit again this year. This profit will go towards a new computer for next winter - the one we have now is too slow for our purposes.

Modem input was up with BC Highways finally coming on-line for the last half of the winter. About 80% of the subscribers can now send and receive data by modem. A few subscribers came on-line using Internet e-mail It works, but there were a few problems with time lags. However, I do foresee this avenue being used more and more in the future.

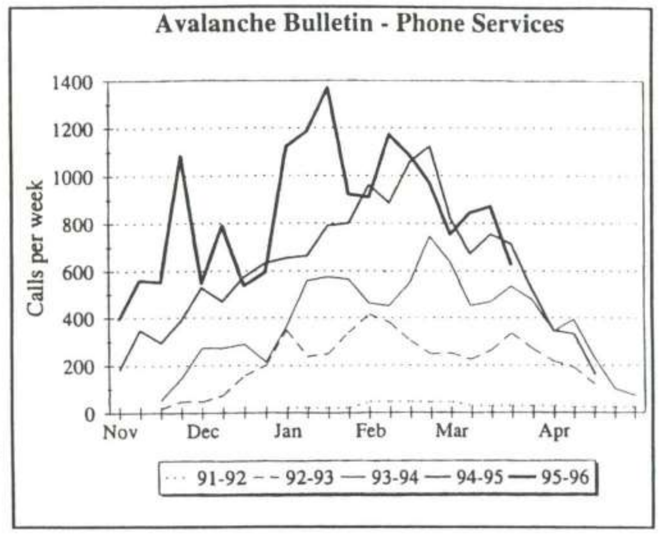
Next season, we will be making the InfoEx available to some new subscribers on a daily basis. This will allow private guides and courses to exchange data with the full-time operations. These new subscribers will still need to be CAA members to be eligible and they will sign a letter of agreement as do all other users. The cost for this level of service will be $10/day.

As most of you probably know, I regret that I won't be managing the InfoEx next winter.The Canadian Avalanche Centre is hiring a new individual for September 15th. To ensure a smooth transition, I'll be training the new InfoEx Manager. It will be business as usual by next season.



# Public Safety Service

The Avalanche Bulletin is the primary public safety product of the CAC. The graph shows the growth in the use of the Bulletin over five years. It is an advisory about current avalanche danger and an opportunity to pass on information about safe travel, snow stability evaluation techniques and current news. It would not be possible to produce the Bulletin without INFOEX which provides the technical information the report is based on. The Bulletin continues to receive strong support from the partners shown on the back page of this issue.




Two public safety events are particularly noteworthy. In the fall the University of Calgary Outdoor Program once again hosted an Avalanche Safety Workshop. The theme developed by Karl Klassen was "Making Decisions in Avalanche Terrain". Once again a variety of well known speakers gave their time to make for a very worthwhile weekend and with attendance at nearly 200, a good sum of money was raised to help pay for the Bulletin. Another Workshop is planned for 23 November in Vancouver. The theme for this years workshop will be "Learning from Our Mistakes". These workshops are an important fund raising source for the Avalanche Bulletin.

Bruce Jamieson and Torsten Geldsetzer are working on writing the book "Avalanche Accidents in Canada - Volume 4". This book will focus on accidents since 1984. It will be available for sale this winter. Support funding for this book has been received from the National Search & Rescue Secretariat.

With financial support from the National Search and Rescue Secretariat the CAC has been able to produce the recently completed avalanche rescue video "Beating the Odds". The production received tremendous support from a great variety of companies including BOMBARDIER, CMH, YELLOWHEAD and local Valemount companies where most of the video was shot. The premier showing was at the CAA AGM where it was well received by a rather biased audience. In June at the International Snowmobiler Manufacturers Association conference in Edmonton it was enthusiastically received by an audience with a good critical eye. We look forward to wider distribution of the video over the next few months.

It is interesting to note, in other areas of public awareness, the difference in some of the popular journalism and videos between the way avalanche danger is presented now and what has been the "Warren Miller/No Fear" approach of the past. The best two examples seen at the Centre were an article in TransWorld Snowboarding by Eric Blehm and the video Locomotion by Christian Begin. The photo captions in the extreme snowboarding article asked the question "does this guy know about the slope stability?" In the video, the story was developed around the different perception of avalanches between the uninformed victims of the Rogers Pass avalanches early in the century and the recreational pursuits that take place where the spirit of those pioneers still live. The publication "Ski Freak Radical" also shows a keen awareness about the importance of communicating a sense of responsibility about extreme activities in avalanche terrain. It's nice to see this change.

Watch for the Web page in November - http://www.avalanche.ca/snow and issue number 50 of the Avalanche News.

## Publications

*Avalanche Prediction for Persistent Snow Slabs* by Bruce Jamieson. $30.00. Available from: Snowline Technical Services
7943 - 48 Avenue NW
Calgary, AB, T3B 2A7
ph: 403-288-0803, email: 73122.1110@compuserve.com

*The Contribution of Scientific Research to Safety with Snow, Ice, and Avalanches* edited by Anena, Cemagref. FF 200 + postage.
Available from: ANENA
15 rue Ernest Calvat
38000 Grenoble, France

## Notice of Meetings

**National Search and Rescue Secretariat**
Search and Rescue Workshop, 16 - 19 October, 1996.
Dartmouth, Nova Scotia. For information call 800-727-9414
Nominations for "Outstanding SAR Achievement Award" are being accepted by the NSS. Please call 613-996-3035 for details.

**International Glaciological Society**
International Symposium on Snow and Avalanches
Chamonix, France, 25 - 29 May, 1997.
Information and registration: International Glaciological Society
Lensfield Road, Cambridge, England
phone: +44 122 335 5974 fax: +44 122 333 6543

# Canadian Avalanche Association Public Meeting

## 08:30, May 9th, 1996

Marc Ledwidge presented the opening remarks.

Alan Dennis outlined how the Public Safety Bulletin is compiled for the four regions of the province as well as the 5 year trend of use, revenues, and costs. This past season there were 30,000 direct "hits" and possibly as many as 100,000 indirect "hits". A "hit" is defined as one reading of the bulletin. An indirect "hit" would be when it is printed out and displayed, for example in a store, then read. The Internet posted bulletin now has the most "hits".

Alan also discussed the avalanche danger scale. Attempts are being made to standardize and clarify the language for public use in Canada, USA, and Europe.

Jennifer Clark did a presentation on the Internet distribution of avalanche information through a system called CSAC. She outlined how the system works and presented data on the amount of worldwide use through the Internet of both the CSAC and the CAA bulletin.

Bruce Jamieson presented the recent results of research on the compression test (see his paper in this issue). He outlined how and where the tests were done and presented the preliminary results. They are summarized as follows: the bigger the blocks the more taps necessary for failure; a 30 cms x 30 cms block is preferred; an increase in slope angle does not appear to have a strong effect on test results; there does not appear to be a significant difference as a result of shovel shape or orientation; the rutschblock tests correlate with compression tests. Bruce ended his presentation by saying more testing must continue for credible conclusions to be made.

Peter Schaerer presented the IKAR report. For 1995, IKAR was held on September 22nd and 23rd in Norway. The twenty year average for avalanche fatalities is 152 per year. During the 1994-95 season there were 140, with 28 in the USA and 15 in Canada. Statistics show that North America has the most snowmobile accidents. 57% of the fatalities occurred in the backcountry with most victims not carrying transceivers. An increase in accidents, during December and May, has been observed.

Peter also reported that long discussions centred around the Avalanche Rescue Balloon Pack tests that were carried out in Switzerland. It was found that it takes time to react to an avalanche and inflate the balloon and more time for the balloon to inflate. It was reported to be heavy and uncomfortable to wear. The avalanche victim tended to come to rest face down. It did not prevent burial but helped. The cost of the balloon pack is around $1500-$2000. IKAR recommended further tests and improvement.

A discussion was also held regarding the Recco location system. It was agreed that it did help locate victims but has been declared illegal in Austria and Germany.

The Avalanche Danger Scale is accepted and used freely throughout IKAR countries. There are some differences in wording but colours and classifications are accepted.

John Tweedy presented an update on the control methods and strategies for Kootenay Pass. Phase 1 was the installation of the 105 mm. recoilless rifles. Sound and over pressure studies showed 147 rounds could safely be fired in a 24 hour period. John then outlined phase 2 which involved the installation of 3 Gazex cannons on Stagleap Mountain. These cannons have proved effective at producing significant wide avalanche propagation. The cannons cost a total of $500,000 installed and operate at $15 a shot.

He then outlined the proposal for phase 3 of the program which calls for an additional 10 Gazex cannons and 3 buildings. This phase is planned due to the limited number of 105 rounds available and the high usage rate in the Kootenay Pass program.

Juerg Schweizer, an avalanche researcher from Switzerland doing studies in Canada, presented a overview of avalanche problems and solutions in Switzerland. Statistics included: an average of 28 fatalities per year; $100 million per year for avalanche protection instead of an expected $3 billion per 3 years in avalanche damage; and 55.5 tons of explosives used per year for avalanche control with the majority used in heli-bombing and hand charging. Juerg also presented a land area comparison between BC and Switzerland and the various avalanche hazard mitigation methods such as land use planning, structural defences, reforestation, and education. The final segment of his talk covered the town of Davos and it's well known research centre.

Tim Auger outlined the work done by Parks Canada to develop a method which increases the speed and the probability of a strike when probing an avalanche deposit. Statistics show that avalanche victims are most likely survive if they are 1.5 to 2 metres deep. Parks staff ran tests limiting the probing to 1.5 metres as well as increasing the number of probings, per step forward, each rescuer performed. The tests indicated that if each rescuer performed three probes per step (1 centred and one each left and right), 1.5 metres deep, the probe line was able to cover the same area 30% faster, than when using conventional probing techniques. This new method of probing produced a 95% probability of a positive strike (see paper this issue).

Ken Little of the AES gave an outline on the Mountain Weather Training course developed by AES for training avalanche professionals. The outline was well received and the course will be available next winter.

Nic Seaton gave an summary on the transceiver tests carried out during the winter of '95-96' on the Arva 8000, Pieps 457 with the opti-finder, Ortovox F1 focus, and the Survival On Snow transceiver. The Arva 8000 still appears to have the greatest range but Nic indicated that the buyers should not focus only on this fact. Serviceability, dependability, and warranty should also be considered before committing to any one transceiver.

Torsten Geldsetzer reviewed the avalanche accidents and fatalities for the '95-96 season. The total of 5 fatalities was the lowest number since 1974 (since the meeting three more people were killed in an avalanche accident in the coast mountains). The seasons fatalities occurred on: November 12th on Baffin Island, a snowmobiler; December 22 in Robertson, Quebec, 2 ski tourers; January 4th in Stagleap Provincial Park in BC, a snowboarder; and February 26th in Kokanee Provincial Park in BC, a ski tourer. 64 accidents involving 88 people were also reported. The statistics breakdown as follows: backcountry-57; ski areas-3; out of bounds at ski areas-11; snowmobilers-1; climbers-8; and others-8. The accidents occurred in the following areas: coast-13; interior-26; Rockies-21; and other parts of Canada-4. Of those that survived a complete burial: 9 were recovered using transceivers; 2 were recovered because of movements in the snow.

Adrian Wilson, representing Mountain Watch Inc., presented a review of the glide avalanche research project in Galena Pass.

Gord Ritchie gave a presentation on the CSPS avalanche training program. This included avalanche training courses with 160 students, public safety and awareness courses with 955 students, a well circulated avalanche awareness pamphlet, and an instructor development program.

John Heshka summarized the BC Provincial Emergency Program (PEP). He spoke of the avalanche rescue needs of PEP and requested assistance in improving their avalanche burial response abilities.

Karl Klassen premiered the CAA avalanche rescue video as the final presentation of the meeting. The video was positively received.

## International Symposium to Celebrate 60 Years of Snow and Avalanche Research at Davos

### Snow as a Physical, Ecological, and Economic Factor

**First Announcement:** The Swiss Federal Institute for Snow An Avalanche Research in collaboration with the Swiss National Panel of IG3P will hold an international symposium on snow and avalanches in the European Alps and worldwide from Nov. 20 to 23, 1997 in the Congress Centre, Davos, Switzerland. The three main topics are: 1. Snow Cover Ecology 2. Snow and Avalanche Mechanics 3. Snow and Economy

**Language:** Joint sessions will be in English or German with simultaneous translation. Other sessions will be English only.
**Congress Fee:** Sfr. 200 - includes proceedings. Reduction for students on request.
**Further Information:** Swiss Federal Institute for Snow and Avalanche Research Fuelastrasse 11, CH-7260 Davos Dor, Tel. +4 +81 417 01 11, Fax. +4 +81 417 01 10 Email: frey@slf.ch

## Job Opportunity

Retallack Alpine Adventures Ltd. is looking for Ski Guides.
Contact: Andy Freeland
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Box 147, New Denver
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ph: 604-358-2777/604-837-2729

## Cover Photo Wanted

*Avalanche Accidents in Canada, Vol. 4* requires a striking photo of an avalanche in recreational terrain for the cover. Fee to be negotiated. Contact:
Torsten Geldsetzer before July 30, 1996.
Tel./Fax: (403) 932-5126
email: TorstenG@msn.com

# Field Studies of the Compression Test

Bruce Jamieson and Colin Johnston
403-220-5821, Fax 403-282-7026
Dept. of Civil Engineering, University of Calgary, Calgary, Alberta T2N 1N4

**Summary**

The compression test involves tapping on a shovel placed on top of a column of snow and noting the failures in weak layers that appear on the smooth walls of the column. Limited data show a correlation for compression scores (number of taps) with rutschblock scores and with the frequency of skier triggering on avalanche slopes.

### Introduction

The test method used for this study was developed by Parks Canada wardens in the 1970s although similar tests may have been developed elsewhere. It is one of a number of snowpack tests that has been used—along with other field observations and information—to assess slab stability. Although the compression test has recently begun to spread west from the Rocky Mountains, its advantages and limitations have not been systematically assessed. This article summarizes our second winter of field studies of the compression test and focuses on correlating compression test results with rutschblock scores and with the frequency of skier triggering.

The compression test is unlikely to prove to be as good an index of slab stability for skiers as the rutschblock which tests an area over 30 times larger and loads the area with a skier. However, compared to the rutschblock, the relative quickness of the compression tests allows more sites to be tested. This is an important advantage given the variability of the snowpack. Also, since the compression test requires only a shovel, it offers an alternative to the rutschblock test for snowmobilers, snowboarders and snowshoers.

Figure 1 Compression test

### Technique

Isolate a 30 cm by 30 cm column of snow deep enough to expose potential weak layers on the smooth walls of the column (CAA, 1995, p. 44-45) (see Figure 2). Rate any failures that occur while isolating the column as "very easy". Place a shovel blade on top of the column. Tap with finger tips, moving hand from wrist and rate any failures as "easy". Tap from elbow, and rate any failure as "moderate". Finally hit the shovel blade with open hand or fist and rate any failures as "hard". In practice, 5-10 easy or moderate taps are applied before increasing the force. For the purposes of the following field studies, 10 taps were applied before increasing the force. For scores from adjacent tests, variability is typically ±2-3 taps 65% of the time (Jamieson and Johnston, 1995).

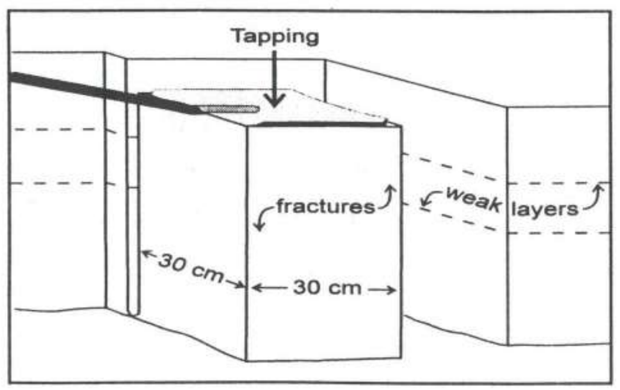


Figure 2 Compression test showing failures in two weak layers

According to the CAA Guidelines (CAA, 1995, p. 44-45), if the snow surface slopes, a wedge of snow should be removed to level the top of column "after surface layers have been tested". Since we observed wobbling of very tall columns (> 1.5 m) when the moderate and hard blows were applied to columns with sloping top surfaces, we decided to level the top of the column after the easy taps from the wrist. This ensures that the moderate and hard taps are directed vertically down the column. Removing snow from the top of the column tends to reduce the number of taps required to fracture weak layers in the remaining column (Jamieson and Johnston, 1995). However, in most cases, the column can be levelled by removing a wedge of snow that is small in relation to the height of the column.

### Compression Scores and Ratings

The CAA Guidelines give four levels (very easy, easy, moderate or hard) for rating the failure of weak layers in response to tapping with increasing force on the top of the column. However, some field workers use "easy-moderate" and "moderate-hard" to describe the transitions. Using our practise of 10 taps per force level, Table 1 gives a six-level rating scheme that includes the easy-moderate and moderate-hard transitions. We define the number of taps to cause failure as the *compression score and the six levels as the compression rating.*

### Interpretation

Sudden failures that appear on the column walls as distinct lines ("pops" or "drops") are more likely to be the failure plane for avalanches than "rough" or indistinct failures. Indistinct failures are sometimes the result of a soft layer "pressing out" next to a harder layer. Experience in the Canadian Rockies suggests that layers with "very easy" or "easy" distinct failures are more often associated with human or explosive triggering than are "moderate" or "hard" failures (G. Israelson, personal communication).

### Experimental Factors

At the Canadian Avalanche Association meeting in Revelstoke on 9 May 1996, we reported on the effect of various experimental factors on compression scores (Jamieson and Johnston, 1996). Briefly, the results are:

Two different designs of shovel blades (varying in size and shape) did not appear to affect the compression rating. Also, we found no strong or consistent effect of the orientation of the shovel blade (facing up or down) on compression ratings.

Increasing the cross-sectional area of the columns increased the compression scores, indicating the advantage of using a consistent size of columns. The 30 x 30 cm columns mentioned in the CAA Guidelines work well.

Compression scores obtained from different operators generally fall in the same range, or occasionally within an adjacent range (e.g. moderate to easy-moderate). It is not common for scores from different operators to spread over three ranges (e.g. easy to easy-moderate to moderate).

### Correlation with Rutschblock Scores

To determine a possible correlation between rutschblock scores and compression scores, three compression tests were done adjacent to one or two rutschblock tests at various sites. At some of the sites, more than one weak layer failed, each resulting in a compression score that corresponded to a rutschblock score.

The median and range of compression scores for 52 rutschblock scores ranging from 2-7 are plotted in Figure 3. For rutschblock scores of 2, the two compression scores are in the easy-moderate range. For rutschblock scores of 4, compression scores are generally in the moderate range. For rutschblock scores of 5 or 6, compression scores range from moderate to moderate-hard. And for rutschblock scores of 7, compression scores are generally in the hard range. (We frequently noticed that compression tests produced a failure in a weak layer adjacent to rutschblock tests in which the same weak layer did not fail.) Except for five rutschblock scores of 3, median compression scores increase as rutschblock scores increase from 2 to 7. Based on these limited and preliminary data, there appears to be a correlation between rutschblock and compression scores. Further field studies are planned.

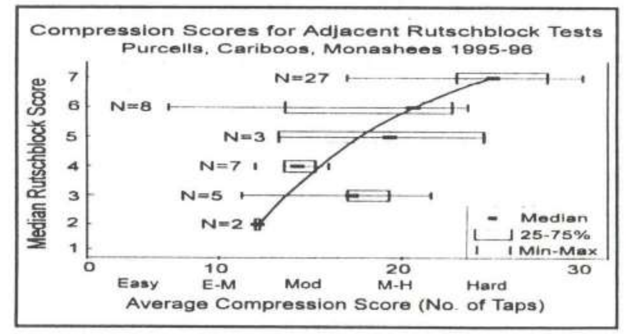


Figure 3 Compression scores adjacent to rutschblock tests

### Correlation with Skier-Triggering

During the winter of 1996, compression tests were done at 21 skier-tested slopes, eight of which produced dry slab avalanches. For each slope, the compression tests were done at a site judged typical of the start zone. On some slopes where skier-testing did not release avalanches, the compression test found more than one weak layer, thereby providing more than one skier-tested slab for the correlation.

The depths of the weak layers for the skier-tested slabs are plotted against the average number of taps required to cause failures in the weak layers (Figure 4). There was only one skier-tested slab with an easy compression score (1-7 taps). Most of the skier-triggered slabs fall in the easy-to-moderate (8-12 taps) or moderate (12-17 taps) ranges. The graph also identifies one slab that was triggered remotely (17 taps) and one that was triggered from near the bottom of the slope (30 taps). Although the site chosen for the compression tests on the bottom-triggered slope appeared typical of the start zone, the high score (30 taps) suggests that the slab was more stable at the top of the slope than at the trigger point 80 m down-slope.

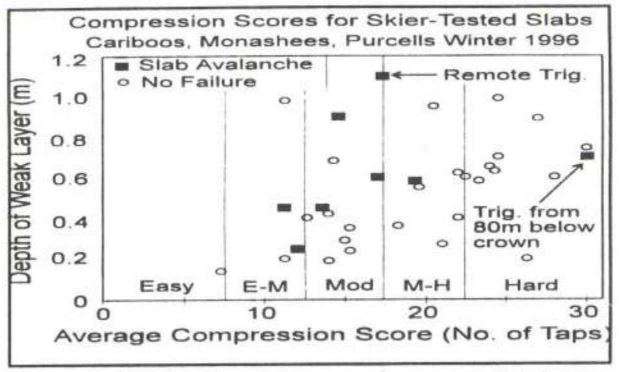


**Figure 4 Depths of weak layers and compression scores for skier-tested slabs**

Using the six ranges of compression scores (very easy, easy, easy-moderate, moderate, moderate-hard and hard), Figure 5 shows the frequency of skier triggering decreasing from 50% (2 of 4 skier-tested slabs) to 9% (1 of 11) with increasing compression scores. Based on these preliminary data, the compression test shows promise as a index of slab stability for skiers. However, because of natural snowpack variability, no stability test done at one or two sites on a start zone can provide a definitive index of stability for the slope (Jamieson 1995, p. 185-194).

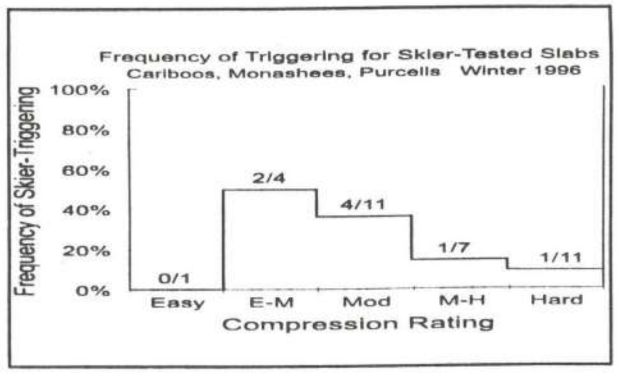


**Figure 5 Compression scores vs frequency of skier-triggering**

Nevertheless, since the compression-tested slabs range up to 1 m in thickness (Figure 4), the compression test appears to have the potential to test slabs over much of the range for which skier-triggering is common.

### Limitations & Future Studies

This article is based on limited data. It is not yet clear if the compression test can identify (and rate) all the weak layers that can produce slab avalanches. For example, on level terrain the compression test may miss certain weak layers such as a poorly-bonded crusts.

Also, the compression scores in this paper are based on the average number of taps required to cause failure in weak snowpack layers. Tests in which weak layers did not fail during the first 30 taps are excluded from the averages (except for the studies of column size). Non-failures should be included in a manner similar to the way rutschblock scores of 7 are included in median rutschblock scores.

Finally, more field studies are required to:

- identify the maximum effective depth for compression tests,
- clarify the effect of slope inclination on compression scores,
- re-assess the correlation of compression scores with rutschblock scores and skier-triggering, and
- correlate compression scores from study sites with the frequency of skier-triggering on surrounding slopes.


### Acknowledgements

This ongoing study is part of a Collaborative Research and Development Project funded by Canada's Natural Sciences and Engineering Research Council of Canada and the following members of the BC Helicopter and Snowcat Skiing Operators Association (BCHSSOA): Canadian Mountain Holidays, Cat Powder Skiing, Crescent Spur Helicopter Skiing, Great Canadian Heli-Skiing, Great Northern Snow Cat Skiing, Island Lake Mountain Tours, Island Sauvage Airmobile Outdoor Adventures, Klondike Heli-Skiing, Kootenay Cat Skiing, Kootenay Heli-Skiing, Mike Wiegele Helicopter Skiing, Mountain Heli-Sports, Purcell Helicopter Skiing, R.K. Heli-Skiing, Retallack Alpine Adventures, Robson Heli-Magic, Selkirk Tangiers Heli-Skiing, Selkirk Wilderness Skiing, Sno Much Fun Cat Skiing, Tyax Heli-Skiing, Tyax Lodge Heli-Skiing, and Whistler Heli-Skiing. In addition to financial support, Mike Wiegele Helicopter Skiing and Canadian Mountain Holidays also provided logistical support and a productive environment for field studies. Thanks also to Gerry Israelson, Clair Israelson, and Peter Schaerer for advice on the compression test, and to Jill Hughes, Sue Gould, Joe Filippone, Greg McAuley and Ken Black for their field work.




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# Canadian Avalanche Association Technical Meeting

## 08:30, May 8th, 1996

Niko Weis called the meeting to order.

Jack Bennetto introduced Don Bachman and Steve Conger of the American Association of Avalanche Professionals (AAAP). He also outlined the additional meetings of the week such as the Associated members, Data Standards Committee, and the CAA/APEGBC meetings regarding professional practice.

Dave McClung gave a presentation on the following projects he has recently been involved in through the U.B.C. Avalanche Group: testing of the Crocus snowpack simulation program in Rogers Pass and Blackcomb; risk mapping for highways and land use; and avalanche dynamics relating to the effects of temperature on fractures in dry slab avalanches.

Bruce Jamieson presented an outline on the avalanche research sponsored through the University of Calgary. This research involves: propagation and remote triggering of avalanches; strength within the snowpack as measured with the shear frame and documented using photos of the snow crystals; and analysis of compression tests.

Paul Orr of the Workers Compensation Board (WCB) reviewed the Manstart fuse problems. He informed the membership that the WCB requires written reports of misfires\problems to enable them to put pressure on the manufacturers. Paul reviewed his work pertaining to helicopter bombing and his perceived problems, the main glitch being the jettisonable box. The board will continue with it's review and intends to produce generic guidelines.

Mark Klassen reviewed the problems at Lake Louise with slow burning fuses. Discussion then followed concerning double priming shots.

Torsten Geldsetzer presented a review of the InfoEx/Data Standards. There are now fifty subscribers on InfoEx with eighty percent communicating through a modem. The problem of little or no input from seven operations was discussed.

Bruce Jamieson did a brief talk on the upcoming ISSW.

After the break Torsten introduced representatives of three weather forecast services and gave them time to outline their operations and services. They were Jim Steel of AES, Scott Morgan of Rocky Mountain Weather Products, and Bob Bloggs of World Weather Watch. After their presentations question were received from the floor.

Jack Bennetto introduced the topic of professionalism and continued competence of CAA members.

Bruce Jamieson opened the discussion with an outline of the objectives of the discussion and the expectations placed on members. Peter Schaerer outlined the purpose of the CAA, maintenance of membership and the importance of the membership committee. Chris Stethem described the definitions, attributes, responsibilities, and expectations of a professional. Peter Schaerer reviewed the code of ethics for the association. Bruce Jamieson concluded the presentation with the topic of entry requirements.

Much discussion followed regarding options for continued competence.

# Avalanche Probing Revisited

Tim Auger
Banff National Park
and
Bruce Jamieson
Dept. of Civil Engineering, University of Calgary

Avalanche probing is still required to search avalanche deposits when other rescue means such as transceivers are unavailable. For many years the most common method employed by organized rescue teams in western Canada has been the technique known as coarse probing. In coarse probing the rescuers line up elbow to elbow and probe the snowpack once per step as the line of probers advance. This technique produces a pattern of probe holes on a 75 x 70 cm grid. The probability of detection ranges from 20% for a vertically oriented victim to 95% for a prone or supine victim and is considered to average 76% (Schild, 1963, 1974).

The idea behind coarse probe spacing recognizes the need to sacrifice some thoroughness to improve the speed of probing and thus maximize the chances of recovering a victim alive. The decision to employ coarse probing reflects the sort of trade-offs or risk-management familiar to the modern incident commander. In avalanche searches requiring manual probing the problem, in simple terms, is how to get as many holes into the snow as fast as possible.

This paper examines two possible means to improve the speed and efficiency of probing in rescues where there is still a possibility for live recovery. Limiting the depth of probing is discussed and several alternative probing techniques are compared.

## Limiting Depth of Probing

The concept of restricting the depth of probing is not new. Lacking sufficient burial statistics, Perla (1967) assumed that avalanche victims were distributed uniformly in the top 3 m of an avalanche deposit, and concluded that limiting probing depth would not increase the probability of finding avalanche victims alive. However, recent Swiss and US statistics on burial depth (Figure 1) represent adequate samples for re-consideration of optimum probing depths.

It is clear that survival is related to depth of burial. Deeper burial likely means more restricted respiration and denser snow deposition containing less air. Deeper burial often results from larger and thus more violent events. Since deeper burial is more likely to mean the victim has already succumbed, it makes sense to consider limiting the depth of probing if it improves the odds of finding the victim who is more likely to still be alive because of shallower burial.

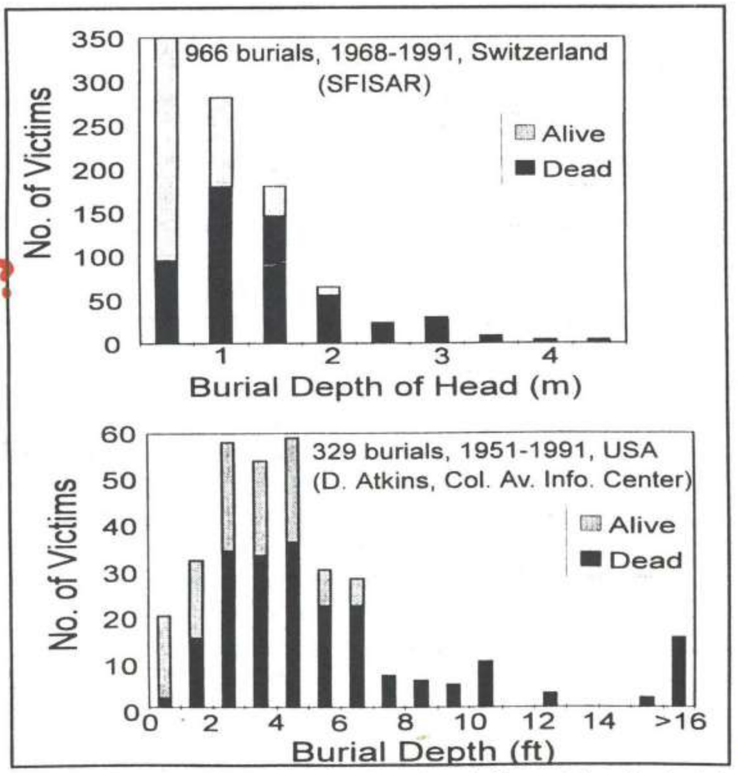


**Figure 1** Number of avalanche victims found alive and dead by burial depth. Swiss burial depths (in metres) and US depths (in feet) are scaled for comparison.

If the depth of probing is limited, the speed of probing should increase because the probe does not travel as far. Speed is further improved if the probe itself can actually be shortened making it easier for the rescuer to manage.

Is there an optimum depth of probing? Both sets of statistics show the total number of victims buried in avalanches decreases at depths below 1.5 to 2.0 m. Perhaps more significant is the sharp decline in the proportion of survivors at depths greater than 1.5 to 2.0 m.



If the rescue leader is faced with searching a vast area, he may opt for a shallower probe depth not only to speed up the rate of probing, but to focus the search on that part of the debris most likely to contain a victim who is still alive.

| Test # | Probe Pattern | Depth Probed | Probemaster Used | Probe Type | Probe Rate (holes/person/minute) |
|---|---|---|---|---|---|
| 1 | Coarse Probe | Full Depth | Yes | 4-section | 7.42 |
| 2 | Coarse Probe | 1.5m | Yes | 3-section | 8.03 |
| 3 | 3 holes per step | 1.5m | Yes | 3-section | 13.21 |
| 4 | 3 holes per step | 1.5m | No individually paced | 3-section | 12.06 |

**Table 1** Comparison of field test results

We chose 1.5 meters (close to 5 feet) as the test depth for limiting probing. This depth would reach approximately 68% of the total victims in the US database and 88% of those recovered alive. Using the Swiss statistics, 85% of the victims, or 95% of those recovered alive, were found at depths less than 1.5 m.

The effect of shortening the probes, and limiting the depth to 1.5 m is discussed in detail in the next section.

## Field Tests

Field tests of various techniques were conducted at Roger's Pass, BC on March 29, 1996. An undisturbed snowpack over a large flat paved parking area was chosen as a test site and found to contain consistent one finger resistance snow over a uniform 2.1 m depth throughout the entire area. Foot penetration was about 2-3 cm. The force required to penetrate the snow with a probe was consistent and typical of an avalanche deposit.

The area was divided into a series of identical corridors the width of a 9 member probe line and 50 m in length. The probers were instructed to probe at a realistic rate which they felt they could maintain for an extended period ("at least an hour non-stop"). The number of steps was controlled and recorded and thus the exact number of probe holes could be determined. The time for the team to complete each 50 metre stretch was recorded.

Four different sets of tests were conducted, each employing a variation of probing technique. Each 50 metre plot was repeated four times and the probing times were averaged.

Two basic techniques were compared. Two tests employed 9 probers in the traditional coarse probe spacing. The alternative technique employed 3 probers spaced openly to cover the same area as above however each prober placed 3 holes per step. This is a variation of the open-spaced technique described in Perla and Martinelli (1976, p. 192) and McClung and Schaerer (1993, p. 191).

Bilgiri probes were used. Full depth probes employed 4 sections (3.25 m). The probes were shortened to 3 sections (2.45 m) for three of the tests. One test was full depth (to ground) 2.1 m. The remainder were to a depth of 1.5 m. The probes were marked with tape to indicate 1.5 m.

The usual probemaster was employed to direct the 9 member probe line. In one of the open spaced tests the team was instructed to proceed at their own individual paces.

## Field Test Results

Times were averaged for each technique and the rates of probing were calculated: see Table 1.

## Three-Hole-Per-Step Probing

The open-spaced technique illustrated in McClung and Schaerer (1993, p. 191) shows each rescuer probing twice per step. In the technique employed in these tests, each person probed three times each step, to the left, in centre, and then right.

In reality if the prober reaches to the side, the probe will usually enter the snow at an angle. If he tries to maintain the 75 cm spacing the angle may be 10-15 degrees from vertical. However if the probers space themselves finger-tip to finger-tip apart (~175 cm) the resulting lateral spacing of probe holes is reduced to about 60 cm at a depth of 1 m and the angles of the probe holes on each side are slight.

Figure 2 illustrates the resulting probe coverage for this technique in a vertical plane through the snow.

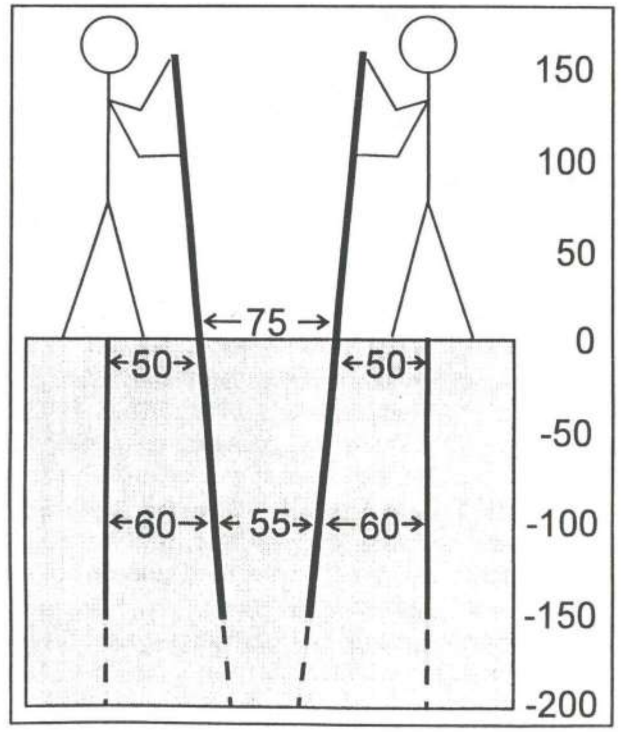


**Figure 2** Probe spacing in vertical plane for 3-hole-per-step probing. Optimal spacing occurs approximately 1 m below surface. All dimensions in cm.

## Discussion

Times within each test set were consistent and snow conditions were ideal so it is possible to compare the various techniques.

Test sets #1 and #2 both employed the classic coarse-probe technique but varied the probe length. Using shortened probes and limiting the depth was marginally faster however, since the 'full depth' (test #1) was only to 2.1 m. the results of this comparison are not strongly conclusive.

The only difference in technique between test set #3 and #4 was that the team members in #4 each proceeded at their own pace. We were interested to observe that the group without a probe leader (set #3) produced a higher rate than the individually paced group.

From these tests it appears that the three-hole-per-step method is significantly faster than the traditional coarse-probing method. The reason must relate to the stepping part of the probe sequence. Multi-hole probing requires less walking per unit area. Less steps reduces the delays due to waiting for the slowest prober. It also reduces the absolute amount of walking each rescuer must do. In the test site the walking conditions were ideal. In a normal avalanche site where walking is often difficult, the amount of energy saved, and the improvement of work productivity should be even greater than in this test.

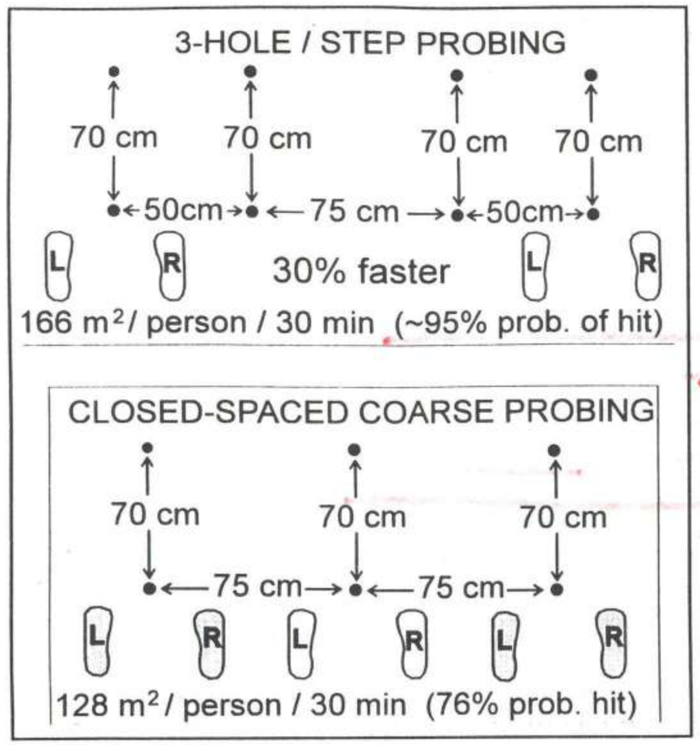


**Figure 3 Comparison of 3-hole-per-step probing and open-spaced probing showing position of holes in snow surface relative to prober's feet.**

The finger-tip to finger-tip spacing between the probers in the three-hole-per-step method results in a finer grid pattern, 60 x 70 cm compared to 75 x 70 cm for coarse probing. Even with this reduced area coverage factored in, the three hole per step technique is still 30% faster than coarse probing. In Figure 3, the area of the respective rectangles compares the productivity of a rescuer using each of the techniques. Furthermore, the denser probe pattern actually improves the theoretical average probability of detection from 76% (for coarse probing) to approximately 95% (calculated for vertical probes hitting an area of 0.4 m²).

## Summary

In avalanche search where time is critical the rescue leader must focus available resources to achieve the highest probability of success. We are taught to priorize the area of the search to try to reach the victim more quickly. The extensive historical data now available on burial depths permit the rescue leader to consider focusing the search even further by limiting the depth of probing. Recent statistics indicate that the majority of victims are buried within 2 m of the surface and that the proportion of victims found alive decreases with depth of burial and decreases markedly around 1.5 m.

It is our proposal that if the rescue leader is faced with probe-searching while live recovery is still a possibility, he should consider limiting the depth of probing in the interests of speeding the search.

Based on trials in compact level snow, probing 1.5 m depth, 3-hole-per-step probing is 30% faster. For a victim of average size and orientation, 3-hole-per-step probing increases the probability of detection from 76% to approximately 95%.

Our field tests indicate that 3-hole-per-step probing also significantly improves the speed of searching. Setting up the probe line for this technique is easy using finger-tip-to-finger-tip spacing. The effectiveness of traditional coarse-probing is dependent on a high degree of discipline of the search party where maintaining correct spacing is important. However, with the three-hole-per-step technique described here, if the searchers happen to wander slightly off line they will still be putting down a higher density of holes than traditional coarse probing.

With the three hole per step technique, 2 probers cover a width almost equal to 5 coarse probers. This deployment may have the added psychological effect of encouraging small parties (self-rescue situations) to energetically pursue probing because the spacing of the probers does not appear so hopelessly inadequate in comparison to the area to be searched.

Some searchers and search leaders may already be employing these principals. These data and tests should supply a greater confidence in choosing to vary from the traditional techniques.



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# Terminology: Whumpfs and Propagating Shear Fractures

Bruce Jamieson and Dave McClung

Avalanche workers and recreationists take "whumpf" sounds from the snowpack as indications of local instability. Such sounds are caused by propagating shear fractures which may travel and release avalanches on steeper terrain (McClung and Schaerer, 1993, p. 135). However, we lack a consistent term to describe this important phenomenon. Various terms such as "settlement", "subsidence", "whumpf" and "snow quake" have been proposed. In this note, we review the terms from an Engineering and Earth Science perspective, and make a recommendation.

Settlement: Gradual compaction of porous media such as soils under their own weight or additional load (building, etc.). This is ideally suited to the gradual compaction of snow layers under their own weight. Although it is potentially misleading to use this term to describe propagating shear fractures, the usage is common among recreationists and ... well, we have all used it.

*Subsidence*: Gradual or sudden downward displacement of surface caused by natural or artificial removal of liquid or solid material (mining, wells, etc.). This term is used in some avalanche safety operations to describe fracture propagation along weak layers or interfaces.

*Snow Quake*: For firn (snow that has survived the summer), a firn quake is fracture that propagates along a weak layer and usually identified by distinctive travelling sounds. Downward displacement of the surface is often reported (DenHartrog, 1982). Since "firn quake" remains in use by glaciologists, some people have suggested that "snow quake" be used by avalanche workers and recreationists to describe the same phenomenon in the winter snowpack.

*Whumpf*: Words that sound like physical phenomena (e.g. squeak, crunch, thump, etc.) are common and clear to recreationists. Some, such as "thunder", are also used in the sciences. In technical and informal writing in German, the phenomena of propagating fractures along weak layers or interfaces are called "whums". Nevertheless, some avalanche professionals in Canada are reluctant to use "whumpf", particularly when communicating technical information.

## Recommendation

We prefer the terms "whumpf" and "propagating shear fracture". Both are unambiguous. "Whumpf" is used by recreationists, avalanche workers and scientists in the Alps. If it sounds too informal for certain usage, or to describe (rather than label) the phenomenon, we suggest "propagating shear fracture".

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