AVALANCHE *news*

canadianavalancheassociation
Volume 71 *Winter 2004-05*

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inside

cac launch

Find out more about the public arm of the CAA.

rapid rescue

ICAR's new recommendations for on-site treatment of avalanche victims.

research

Poorly bonded crusts, small-scale mapping of snow stability, and more.

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table of contents

Table of Contents


Kokanee
GLACIER BEER
Kokanee
GLACIER BEER
BC'S GLACIER FRESH TASTE
*TM/MC Columbia Brewery

canadianavalancheassociation **Avalanche News** Volume 71 ❄ Winter 2004-05

Avalanche News is the official publication of the Canadian Avalanche Association, a non-profit society based in Revelstoke, BC that serves as Canada's national organization promoting avalanche safety. The goal of *Avalanche News* is to keep readers current on avalanche related events and issues in Canada. *Avalanche News* is published quarterly.

Avalanche News fosters knowledge transfer and informed debate by publishing submissions from our readers. Responsibility for content in articles submitted by our readers lies with the individual or organization producing that material. Submitted articles do not necessarily reflect the views or policies of the Canadian Avalanche Association.

Avalanche News always welcomes your opinions, teaching tips, photos, research papers, survival stories, new product announcements, product reviews, book reviews, historical tales, event listings, job openings, humourous anecdotes and really, *anything* interesting about avalanches or those people involved with them. Help us share what you've got. Please send submissions to:

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Editor Mary Clayton
Graphics & Advertising Brent Strand

Content Deadlines:
Material is due on the 1st of February, May, August and November for our spring, summer, fall and winter editions respectively.

Note: Digital contributions work best for us. For details, contact Brent Strand at publish@avalanche.ca.

Editor's View

Is there anything as satisfying as seeing a hard-fought battle finally won? That great feeling of accomplishment and satisfaction was evident here at the Canadian Avalanche Centre recently, with the news that the University of Calgary has named Dr. Bruce Jamieson as the NSERC Industrial Research Chair in Snow Avalanche Risk Control. The establishment of this position represents a culmination of hard lobbying and persistence from many players in the avalanche industry. Through these efforts, university administrators and National Sciences and Engineering Research Council of Canadan (NSERC) members were convinced of the vital need for avalanche research in this country, and the decision was made to create a position that allows Dr. Jamieson to continue his excellent work. Everyone involved should be immensely proud of this accomplishment. Congratulations Bruce.

This issue of *Avalanche News* is the result of another type of hard-fought battle. In early November I was hit by a truck while crossing a street and I sustained a number of injuries. Each and every ball I had in the air – from both my professional and personal life – all crashed to the ground. At a time like that priorities shift, and my healing took precedence over everything else. Fortunately, we have some talented people here who to came in and picked up some of those dropped balls. I'd like to say a big thanks to Barbara Rose, who agreed to take over my position as editor and made sure *Avalanche News* got to the printer on time. I'll turn the remainder of this column over to Barbara, and wish everyone a great, and safe, winter. See you in the spring.

M. Clayton

I have been on the periphery of the avalanche community for only a few years. I barely know enough about the mainstay avalanche programs and key players to make polite conversation, or at least to not glaze over at an inopportune time. But after spending the better part of a month pouring over many articles, research papers and general correspondence and talking with those responsible, I have learned a few things: 1) that the spectrum of avalanche-related initiatives is extremely broad; 2) that there are an awful lot of incredibly talented, dedicated and interesting individuals out there working to ensure the safety of novices like me in avalanche terrain; and 3) that there is always something new to learn. For me, putting this issue together was an eye-opener, and I hope each of you finds something in these pages equally valuable.

On page 30, Canada's new representative to International Commission on Alpine Rescue's (ICAR) Medical Subcommission, Jeff Boyd, brings us the latest thinking on medical treatment of avalanche victims in the field. The recommendations reflect the collective wisdom of some of the most prominent medical practitioners from the world's alpine nations. We're pleased to bring this information to a Canadian audience.

To coincide with the recent announcement of the NSERC Research Chair, Mary had planned to profile Bruce Jamieson. In the end, I felt it would be inappropriate for me, as guest editor, to try and summarize Bruce's achievements and contributions, I made an editorial decision to postpone this profile until the spring when Mary returns. We do, however, have the second installment of Bruce's three-part examination of poorly bonded crusts. You will find it on page 34.

On page 38, we present the research paper "Avalanche Winter Regimes", in which Pascal Hägeli re-examines the way snow climates are currently described. His very progressive views could have long-term implications in the way avalanches are forecasted in Canada and internationally. It's another example of how much more there is to learn about snow and the value of critical thinking.

Typically, the Transitions portion of *Avalanche News* focuses on changes within the CAA staff. In this issue we made the decision to include someone from outside our offices because his transition is equally deserving of our attention. Dave Skjonsberg's many years of avalanche control work at Rogers Pass will ensure him a place in Canadian avalanche history. Read his farewell letter on page 58.

This issue marks the final installment of the CAA's Oral History Project. We hope you've enjoyed reading it and learned a little something along the way about the people involved and their pioneering efforts. Our thanks to Christine Everts for her hard work in turning so many individual memories and anecdotes into an enjoyable and thoroughly readable account.

Finally, it is true what they say about one person's misfortune being another's good fortune. At the risk of sounding heartless, the reality is that if it weren't for Mary's accident, I would have missed this opportunity to work on the *Avalanche News.* More importantly, I would have missed the chance to work with some fantastic people here at the CAC. My thanks to each of you, especially Mary for having the confidence in me to sit in the editor's chair and to Brent for patiently nursing me through the process. I hope you enjoy this issue as much as I enjoyed putting it together!

Executive Director's Report

BY CLAIR ISRAELSON

We are entering another winter season with a sense of excitement and anticipation. We are fortunate to be part of a dynamic Canadian avalanche community that has a long history of continuous learning that leads to ongoing operational improvements. Essential new knowledge is coming from research programs at Canadian universities. Practitioners trade experiences and learn from each other. We import expertise and technology from around the world to help us manage our avalanche programs better. We have come a long way in the past 30 years.

We work in a complex and constantly changing environment. Every day we collect and analyze an incredible volume of data and subjective information. We try to recognize trends and patterns in that data and information, identify and prioritize the risks, and formulate good decisions to manage those risks. We are responsible for the safety of others, and ourselves, and take pride in our work. As we celebrate our successes we recognize that we still make decisions that have unintended and sometimes tragic consequences.

All of us want a safe season. Yet despite our efforts we continue to lose the lives of good people to avalanches. Thinking back over the past decade or so, it seems that almost every year an avalanche worker is killed or seriously injured. We're starting to learn that human factors can have a profound influence on our decisions.

Over the years I've made my share of poor decisions in avalanche work, and I'm coming to appreciate that in most instances those poor decisions were the result of my personal failure to manage my own "human factors." I knew the risks that existed, but somehow I convinced myself that everything would be OK. I took chances without thinking enough about the consequences, assuming I'd be lucky. Occasionally I was unlucky.

In January 1987, I was responsible for the safety of a group of backcountry skiers and made a poor decision that resulted in a serious injury to a young man. I was instructing a CAA Training Schools Level 1 course at Mt. Assiniboine Provincial Park. All week we had been observing a fairly normal Rockies snowpack – 15 cm of soft snow over a strong-mid pack layer, then a layer of weak facets, a second stronger layer below the facets, and then depth hoar at the base. Throughout the course we avoided slopes steep enough to avalanche; the instability in the snowpack was obvious.

Friday was the last field trip of the week, a full day out in the mountains. It was a blue-sky day, and the views were stunning. I had a great group, strong mountaineers who were all excellent skiers. I really wanted to show them a great final day on their course. As we toured up and over our summit we kept testing the snow, always seeing the same thing: a weak mid pack layer of facets that failed during stability tests. We continued to sneak around every pitch that promised good skiing.

Late in the day we arrived at the top of the last slope that offered skiing. The slope was steep but relatively small, studded with larch trees. The slope promised untracked boot-top powder. Someone whispered, "Come on, let's ski this one." I was in a quandary. I knew the snowpack was inherently unstable, but these folks were all excellent skiers and desperately wanted some good skiing to finish off this incredible day. Searching for a way to accommodate our wishes I came up with what I thought was the perfect compromise. After all, this *was* an avalanche course. We would practice "safety measures."

> *Someone whispered, "Come on, let's ski this one." I was in a quandary. I knew the snowpack was inherently unstable, but these folks were all excellent skiers and we all desperately wanted some good skiing to finish off this incredible day.*

We removed our ski pole wrist straps. We unbuckled the safety straps on our skis, and the waist straps on our packs. We posted an avalanche guard and talked about how we would ski one at a time, and where we would re-group. Fred claimed first tracks. I said I would ski down last. Fred launched into the slope. His first turn was fine, and then his skis broke through into the softer mid-pack facets. We watched the slope fracture, only 15 metres wide, and then he was caught and carried down the slope, bouncing off trees as he tumbled with the avalanche. He wasn't totally buried. He groaned as we gently started to remove the snow from around his lower body. His pelvis was broken.

I won't bore you with the details of the evacuation. By nightfall Fred was in the Banff hospital, and a month or so later he was able to return home. For the next six months I would see him hobbling around town with crutches or a cane. Every time I saw him I was reminded that my poor decision had caused an injury that would plague him for the rest of his life. I had failed as a professional. I had allowed my desire to please and the promise of a few good turns to override my professional responsibility for the safety of my group.

I thank helicopter pilot Don McTighe for another lesson about professional decisions in high-pressure situations. We were on a mountain rescue operation on Mount Temple near Lake Louise. A Japanese party of two was overdue on the Black Towers route and we were flying in his Jet Ranger trying to locate them. We spotted a single person in obvious distress, alive but not moving at about 11,000 feet on the summit glacier. I asked Don if we could sling into the site. A power check in tricky winds prompted a firm "no way" from Don, followed by a "but I can put people onto the ridge lower down, one at a time, and they can climb up from there." It was a prudent decision, and a team of rescuers was flown onto the mountain to bring the helpless climber to safety.

As we continued searching we discovered the second climber hanging from a tied off climbing rope on the near vertical wall of a tiny pinnacle. This climber wasn't moving. Climbing in from below was out of the question, but somehow I really wanted to get to this person and help in any way that I could.

Once again I asked Don, "Can you sling us onto the pinnacle?" He pulled into a hover, checked power, and thought for a minute. Then he said, "We could probably get away with it, but I'm not certain. I won't even try." Then he said, "You need to find Jim Davies; later in the day when the wind goes down he might be able to do it." At that moment I learned what professional decision making was really about. This was no place for ego or competition. Don had assessed the risk, and had determined that he was not 100% confident in his ability to conduct the mission safely. His decision was final and he would not be pressured into changing his mind.

Later in the day we were able to get Jim Davies and a more powerful helicopter on scene. As Don had predicted the winds had dropped . The shadows were longer, giving better definition to the pinnacle. We slung onto the tiny spot, and discovered that the climber had died hanging in his harness. There really had been no pressure after all.

To this day when I see Don McTighe, I remember his decision that day on Mount Temple, and my respect for him continues to grow. He did his job as a professional; he kept his safety, and mine, as priority number one.

As we go into our winter season we look forward to the challenge of decision making in avalanche work. Over the course of the season each of us will be confronted with hundreds, perhaps thousands of decisions that have potential to result in injury or loss of life. We take pride in our professionalism, our training and experience. Yet, it seems that we lose an avalanche worker almost every season. As Steve Blake reminded us in his remarkably honest and gut-wrenching report on the death of a Jasper Park Warden, "funerals suck." Perhaps it's time for the avalanche community to reassess some of our attitudes, beliefs and assumptions about decisions and workplace safety.

It would be a true success if we could celebrate an accident-free season when we gather for our annual general meeting next May in Penticton. Will you do your part to make this winter a safe one for everyone in your workplace?

Best wishes for a great winter season,

Clair Israelson
Executive Director
Canadian Avalanche Association

President's Report

BY JOHN HETHERINGTON

The fall season is a time for the CAA to gear up for the coming winter. The first significant event was a special meeting of the CAA held at the ISSW in Jackson Hole, Wyoming this past September. Free beer may have contributed to the excellent turnout and it certainly persuaded a few of our American friends that the CAA meeting would be more interesting than the AAA meeting held at the same time. Many thanks to those who attended.

The incorporation of the Canadian Avalanche Centre (CAC) as Canada's public avalanche safety organization became a reality in October. In essence, the CAC will serve as the "public arm" of the CAA, providing public avalanche bulletins, recreational avalanche courses, etc. The CAA will continue to serve and represent professional avalanche workers across the country.

Ian Tomm kicked off the CAATS program in November with an instructors' workshop in Revelstoke. There was no expense allowance for the instructors so kudos to those who showed up on their own resources.

There has been a considerable amount of discussion amongst CAA staff, the Board of Directors, the Education Committee, and the RAC Providers Advisory Group concerning the Recreational Avalanche Course (RAC) program and, in particular, guidelines for field trips. Some new clauses were added to the Field Trip Policy for RAC instructors. Steve Blake, Director at Large and member of the Education Committee has written about these changes, see page 26 for more information. These clauses generated a fair degree of controversy, but it is incumbent upon the BOD to manage the Association's risk in a prudent manner.

For the first time I was part of the traveling road show that put on the Backcountry Avalanche Workshops in Calgary and Vancouver and I was very impressed with the organization of the events, and the quality of the speakers and their presentations. The attendance in Calgary was very good but there were somewhat fewer people attending in Vancouver. Perhaps competition with the Grey Cup game had something to do with it. The Workshops are an excellent learning opportunity and I especially encourage Level 1 graduates and Affiliate members to consider attending a session in the future.

Grant Statham presented new regulations for custodial groups that incorporate new terrain descriptors for public use (Avalanche Terrain Exposure Scale) and a separate set of technical terrain descriptors designed for use by avalanche professionals. (*Editor's Note: for more information see Grant's article on page 15*) Each of these developments is a result of the Connaught Creek avalanche accident in 2003. The repercussions of the tragic events of that winter will be with us for many years.

With winter upon us, the regular machinery of the CAA is in full swing: the Public Avalanche Bulletins are being produced and distributed by CAC staff; the CAA weather forecasts are now on the website and are being sent to InfoEx subscribers; the first InfoEx report of the season was issued on November 15th; and the CAATS avalanche courses commenced in late November with back-to-back Ski Operations Level 1 courses in Whistler. A follow-up Module 2 (terrain) Level 2 course is scheduled for Whistler and several other courses will be held in other venues in western Canada, and internationally in Japan and Iceland. (*Editor's Note: see page 27 for Ian Tomm's update on the CAATS program*).

In September and early October I heard many predictions of a heavy snow winter, but far fewer predictions were being heard as the reality of late November and early December arrived. At this time of year most of us anxiously monitor the weather and the snowpack to see what it portends for snow and avalanche conditions that may be with us for much of the winter. Very few people are brave or rash enough to predict the number of serious avalanche incidents that may occur this winter, but ultimately all of the endeavours of the Canadian Avalanche Association are directed at keeping this number to a minimum. We may often think of Nature as being capricious but it is merely indifferent – Nature doesn't care what we know about avalanches. The role of the CAA has always been to educate and inform, with the goal being to reduce the number of avalanche accidents. Yet the CAA can only do so much and then it is up to all of the people who are working and recreating in the mountains to prevent and avoid avalanche accidents.

Pray for snow and be safe.

John Hetherington

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PRESS RELEASE

RELEASE AT 2:00 pm MST

CANADIAN AVALANCHE CENTRE ESTABLISHED TO SERVE AS CANADA'S NATIONAL PUBLIC AVALANCHE SAFETY ORGANIZATION

CALGARY, Alberta, November 20, 2004 — Today, the establishment of the Canadian Avalanche Centre (CAC) as a national, not-for-profit corporation was formally announced at a backcountry avalanche workshop. The CAC creates a way for federal and provincial government agencies, the private sector, and not-for profit organizations to collaborate by focusing resources and expertise to develop and deliver world-class public avalanche safety programs.

"Canada is becoming a world leader in avalanche safety through the efforts of the public and private sector," said Ms Jean Murray, Executive Director of the National Search and Rescue Secretariat. "The creation of the Canadian Avalanche Centre takes this cooperation to a new level."

"For the past year we have worked with stakeholders, not-for-profit governance, legal and financial experts, and the Canadian avalanche community to ensure this organization is structured to be transparent, cost efficient and effective," said John Hetherington, CAC President. "We are pleased with the work that has been accomplished to date, and look forward to serving Canadians for many years to come."

The Canadian Avalanche Centre was established to serve as Canada's national, public avalanche safety organization by: coordinating public avalanche safety programming; providing public avalanche safety warnings; delivering public avalanche awareness and education; providing avalanche training for non-professional winter recreation; serving as point of contact for public, private and government avalanche information; and, encouraging avalanche research.

"The Canadian Avalanche Foundation believes the public avalanche bulletins delivered by the CAC are a vital service," said Chris Stethem, foundation President. "The CAF welcomes the public to join us as supporters of the public bulletin."

"The expertise and dedication of Canada's professional avalanche operations and research teams are recognized around the world. Now, we have the capacity to deliver public avalanche safety programs to a broader audience in Canada, with a similar level of professionalism," explains Clair Israelson, CAC Executive Director. "The Canadian Avalanche Centre is designed for Canada's unique needs. This winter, the Canadian Avalanche Centre will begin delivering services in Western Canada. We will continue to work to establish a parallel capacity for public avalanche safety services in Eastern Canada in the near future."

On October 20, 2003, BC Minister of Public Safety and Solicitor General Rich Coleman called for establishment of a national avalanche centre and committed $375,000 over three years from the BC Provincial Government. On February 19, 2004, federal funding and support of $525,000 over three years was announced through Parks Canada and Environment Canada (Meteorological Service of Canada).

"This is another step to enhance public safety in British Columbia and builds on our past support for the Canadian Avalanche Association, the avalanche bulletin, and the Centre," said BC Solicitor General Rich Coleman. "We will continue to work with every level of government and the private sector to improve avalanche programs so that users of the backcountry have the information they need to stay safe."

Operating funds and in-kind support for CAC programs are provided by the BC Provincial Government, Parks Canada, Meteorological Service of Canada, Canadian Avalanche Foundation, private sector sponsors, avalanche operators in Western Canada, public donations and the Canadian Avalanche Association.

Other federal organizations provide support for avalanche accident prevention in Canada. Through their New Initiatives Fund, the National Search and Rescue Secretariat provides funding for avalanche related research and development projects. Science and Engineering Research Canada supports avalanche research programs at selected Canadian universities.

"By funding avalanche research programs in Canadian universities, NSERC is contributing to the urgent need for new knowledge in this field," said Dr. Tom Brzustowski, President of Science and Engineering Research Canada (more commonly known as NSERC). "The opening of the Canadian Avalanche Centre is great news and it will further contribute to making Canadians' backcountry experiences safer and more enjoyable."

For more information contact:
Canadian Avalanche Centre
Phone 250.837.2435
E-mail: info@avalanche.ca
Web site: www.avalanche.ca

National Search and Rescue Secretariat | Secrétariat national Recherche et sauvetage

National Search and Rescue Secretariat welcomes the Canadian Avalanche Centre

The National Search and Rescue Secretariat is pleased to welcome the Canadian Avalanche Centre to the search and rescue community. This new organization represents the most effective means of promoting avalanche safety and education. It creates a mechanism for collaboration between agencies and organizations, applying their individual strengths to the common goal of reducing injuries and fatalities in Canada's outstanding mountain terrain.

"A complex relationship exists between Canada's geography, climate and people" said Jean Murray, Executive Director of the Secretariat. "Keeping people safe in their pursuit of recreation and adventure is important to the quality of life and the economic well-being of the mountain regions. For this reason, Canada's search and rescue professionals are dedicated to continuous improvement in search and rescue, while trying to mitigate the need for it in the first place."

"Canada is becoming a world leader in avalanche safety through the efforts of the public and private sector. The creation of the Canadian Avalanche Centre takes this cooperation to a new level" said Ms Murray.

The two aspects of search and rescue – response and prevention – are well represented within the Centre's mandate. The Secretariat, which was invited to participate in the Centre's development, is pleased to support its goals.

Since 1991, the Secretariat has been contributing to avalanche safety and education by providing over $3 million in financial contributions from the new Search and Rescue Initiative Fund. This fund continues to support innovative programs that will enhance the work of the Centre in the years to come.

The National Search and Rescue Secretariat is an independent agency of the federal government that reports directly to the Lead Minister for Search and Rescue, the Minister of National Defence. Created in 1986, the Secretariat works with all levels of government, police and emergency services to manage and improve search and rescue activities throughout Canada.

November 2004

For more information on the National Search and Rescue Secretariat consult www.nss.gc.ca.

Canada

Gouvernement du Canada Government of Canada

UNIVERSITY OF CALGARY FACULTY OF ENGINEERING

Press Release

Date: November 23, 2004

For release: Immediately

AVALANCHE SAFETY FOCUS OF NEW RESEARCH CHAIR IN CALGARY

(Calgary, Alberta) – The Honourable Anne McLellan, Deputy Prime Minister, on behalf of David L. Emerson, Minister of Industry, today announced federal funding of $673,700 over five years for the NSERC Industrial Research Chair in Snow Avalanche Risk Control at the University of Calgary.

“Each year, Albertans become concerned with the risk of avalanches,” said Minister McLellan. “The University of Calgary’s Dr. Bruce Jamieson will collaboratively develop tools to help backcountry recreationists assess the avalanche risk..”

“Avalanches cause unacceptable loss of lives each year,” said Minister Emerson. “By developing improved tools to assess and predict the risk of avalanche, we will be able to reduce fatalities and injuries.”

The funding is provided through a program of NSERC that promotes research partnerships between the private sector and universities. The Canadian Avalanche Association, Mike Wiegele Helicopter Skiing, the Canada West Ski Area Association and B.C. Helicopter and Snowcat Skiing Operators Association are contributing a total of $592,100 in cash and $200,000 in kind over five years. Parks Canada (Glacier National Park) also provides almost daily advice, data and in-kind support to the Chair’s research program.

The new chairholder, Dr. Bruce Jamieson, is currently an Associate Professor in the Department of Civil Engineering at the University of Calgary, a new position focused on avalanche research. He is well known for his research on properties of weak snowpacks, failure planes, snow slab stability and avalanche forecasting.

“I’m very pleased to be continuing my work with such supportive and forward-thinking partners,” said Dr. Jamieson. “The financial backing and the interaction with avalanche professionals will enable important research into risk control measures and the training of new researchers.”

“Dr. Jamieson’s strong working relationship with his industrial partners as well as his ability to communicate research results to a variety of audiences make him the ideal person to undertake this research program,” said Dr. Brzustowski, President of NSERC. “During the next five years, he will contribute to the training of highly needed and qualified personnel who will advance avalanche forecasting and snow science.”

The Canadian Avalanche Association is Canada’s national avalanche safety organization representing over 700 members. The Canada West Ski Areas Association represents 22 areas/resorts in western Canada with avalanche safety programs. The B.C. Helicopter and Snowcat Skiing Operators Association represents 29 member companies. Mike Wiegele Helicopter Skiing employs approximately 180 persons in its helicopter and resort operations. All of these organizations are interested in sponsoring this practical research program in order to improve their operations and ability to forecast snow avalanches in order to make the mountains safer to all recreationists.

Science and Engineering Research Canada (also known by its legal name “Natural Sciences and Engineering Research Council of Canada” as well as the acronym NSERC) is a key federal agency investing in people, discovery and innovation. It supports both basic university research through research grants, and project research through partnerships among postsecondary institutions, government and the private sector, as well as the advanced training of highly qualified people.

For further information, please contact:

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Letter to the Editor

November 4, 2004
Dear Ms. Clayton:

In your fall edition of the *Avalanche News*, there was mention of rescue dogs that came on the scene in the 60's. The winter of 65/66 I worked as the hill manager at Whistler, and being responsible for avalanche control, I became involved with staff sergeant McDonald of the Squamish RCMP. We discussed dogs for avalanche rescue, and that I had the Austrian dog-training manual for avalanche dogs. He had this book translated and passed onto the RCMP dog trainers. Shortly after I moved to Stewart, BC and lost contact with the Squamish RCMP division. Could this have been the start of avalanche dogs in Canada?

Secondly, the first avalanche course for volunteer ski patrol at Whistler was held that same year (run by me and based on a course I had taken with the US Forest Service in Colorado). It was a weeklong course, run over three weekends. Just of interest: US snow rangers were created for the protection of forests in the US after an extremely large avalanche at Stevens Pass, Washington took out a passenger train and destroyed many acres of woodland. Their field of responsibility was eventually extended to ski areas on public land.

In the beginning of the 60's many avalanche courses were given by Brad Geisler, a volunteer ski patroller from Calgary, and I think he deserves some credit. In the early 60's there was quite a bit of avalanche control in Northern BC, with mining and petroleum companies. One of them was Dome Petroleum out of Calgary. An American fellow by the name of Art Peterson, who worked for American Snowblast Co. of Denver, Colorado, seemed to know where avalanche control jobs took place in the early years, and he did a lot to employ people in the industry of avalanche control.

Maybe some of this would be good for your next edition.

Best regards,

Eric Lomas,
ACMG

BRITISH COLUMBIA

NEWS RELEASE

For Immediate Release
2004PSSG0029-000981
Nov. 22, 2004

Ministry of Public Safety and Solicitor General

ADVENTURESMART STANDS FOR OUTDOOR SAFETY IN B.C.

NORTH VANCOUVER – "Get Informed and Go Outdoors" is the theme of the AdventureSmart program, launched today by Minister of Public Safety and Solicitor General Rich Coleman.

"AdventureSmart is another example of this government's commitment to public safety," said Coleman. "We can prevent needless accidents and injury if people educate themselves about the realities of outdoor recreation so they can be safe, while enjoying all that B.C. has to offer."

Last year in B.C., search and rescue volunteers were called out 955 times to track lost or injured hikers, campers and skiers.The goal of AdventureSmart is to prevent people from getting into trouble by expanding public awareness of outdoor safety whether it's skiing, rafting, hiking or biking.

"B.C.'s remarkable outdoor environment is not without its risks," said Mary Thomas, program officer with the National Search and Rescue Secretariat. "AdventureSmart is designed to address those risks and to help reduce the number of calls for search and rescue."

The provincial government will administer AdventureSmart. The National Search and Rescue Secretariat and the B.C. Search and Rescue Association are providing funding. As well, a number of public and private sector organizations are providing promotional support.

AdventureSmart will encompass a number of outdoor safety programs that already exist and will encourage new ones. Hug-A-Tree and Survive, a program delivered to kids by search and rescue volunteers will be expanded across B.C. under the AdventureSmart banner. Other programs that will benefit include a new YouthSafe initiative to teach outdoor safety guidelines to students K-12, and Avalanche Safety, which targets recreational backcountry hikers and skiers. AdventureSmart youth teams will make presentations at schools, mountain bike races, ski races and other events to deliver the outdoor safety message to teens.

A new website will also help people get safety information before heading outdoors. www.adventuresmart.ca provides information and links to outdoor safety and recreational programs and businesses throughout the province.

"AdventureSmart encourages people to get out there and enjoy themselves," said Dave Norona, a world class adventurer and ambassador for AdventureSmart . "This arms people with the knowledge they need to explore B.C.'s awesome backcountry, but to do it responsibly."

Coleman adds that the AdventureSmart message is preparedness and prevention. "As B.C. moves on to the world stage by hosting the 2010 Olympic and Paralympic Winter Games, we're asking British Columbians and tourists to take advantage of this life-saving information before they head out of doors to enjoy our province."

Media contact: Cindy Rose
Public Affairs Bureau
Ministry of Public Safety and Solicitor General
250-356-6961

Visit the Province's website at www.gov.bc.ca for online information and services.

Parks Canada Information Now Available Online

BY GRANT STATHAM, AVALANCHE RISK SPECIALIST, PARKS CANADA

Parks Canada has applied the new Avalanche Terrain Exposure Scale (ATES) to more than 250 trips in the Mountain National Parks. Each trip now has an ATES rating and is linked with popular backcountry touring guidebooks that describe the trips in detail. This information is distributed online as well as through brochure distribution.

The technical model of the ATES is also available online, and is linked from Parks Canada's daily avalanche bulletins. This style is consistent with a "layered" approach to communication, which is:

Layer 1 – Basic public information (minimal skills required to understand)
Layer 2 – Advanced public information (skills and training required to understand)

As well, a comprehensive online information package is now available for custodial groups. This information details Parks Canada's new standard of care for custodial groups, as well as providing numerous details and links for backcountry trip planning.

Visit any mountain park Web site and look for the green mountain!

www.pc.gc.ca/glacier

Media Release
For immediate release

MOUNTAIN EQUIPMENT CO-OP

Wednesday, November 3, 2004

On-line avalanche series promotes awareness and safety

Vancouver—The Canadian Avalanche Association (CAA) and Mountain Equipment Co-op (MEC) today launched the "2004 Avalanche Awareness Series" at www.mec.ca/avalanche. The series will comprise six feature articles written by avalanche experts to promote avalanche awareness and backcountry safety.

"This initiative by MEC is a wonderful example of corporate responsibility by Canada's leading outdoor equipment retailer" says CAA Executive Director Clair Israelson. "The CAA is proud of our long-standing partnership with MEC and our work together to promote safety in the backcountry."

"Promoting avalanche awareness and backcountry safety is part and parcel of being a responsible outdoor retailer," says Denise Taschereau, MEC's social and environmental responsibility manager. "We developed the avalanche series to help our members and the general public safely pursue their winter adventures."

Twenty-nine deaths occurred as a result of avalanches in Canada in 2002/2003, one of the worst years on record. Canada has averaged 15 avalanche fatalities per year over the last decade.

The series begins with "Trip Preparation for Safe Backcountry Winter Travel," by the CAA's Coordinator of Avalanche Warning Services Alan Jones. In it, he provides tips and advice based on the overriding theme of "be prepared."

The remaining five articles will be published every three to four weeks until early February. The topics will include weather and snowpack analysis, terrain assessment, human factors and search and rescue techniques. Meteorologist David Jones, avalanche researcher Bruce Jamieson, mountain guide Colin Zacharias, engineering consultant Ian McCammon and mountain safety specialist Marc Ledwidge will each write an article.

A brief author interview will accompany each article. Readers will also be able to submit questions to the authors via email.

The CAA and MEC's partnership dates back to 1992. MEC provides financial support to the CAA for its public avalanche bulletins. The CAA trains MEC members and staff in avalanche safety workshops.

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Media Release
For immediate release

MOUNTAIN EQUIPMENT CO-OP

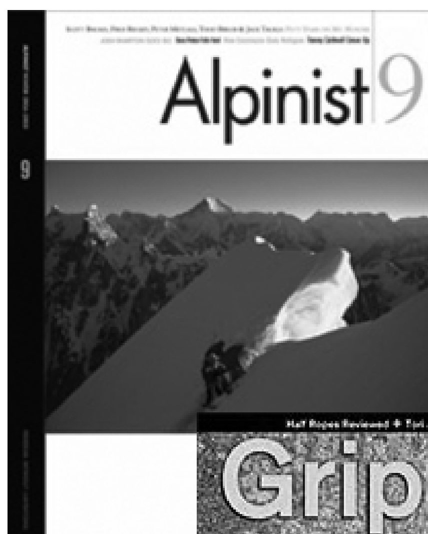
The Canadian Avalanche Association (CAA) is Canada's national organization promoting avalanche safety. The CAA and it's sister organization, the Canadian Avalanche Centre, provide a variety of avalanche safety services to the general public and to those who work in the ski and avalanche industry in Canada.

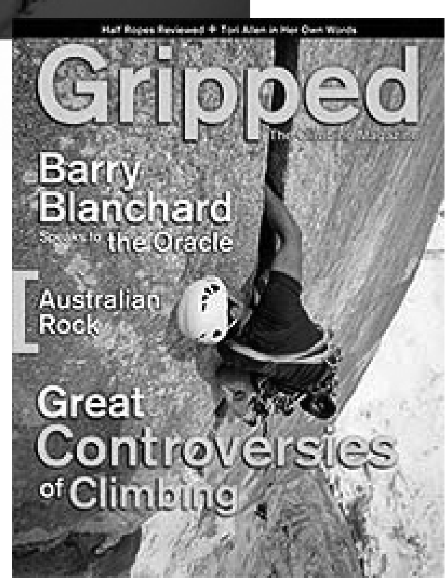
MEC is Canada's largest retail co-operative, providing quality products and services for self-propelled outdoor recreation. Its website received 4 million discrete visits in 2003, and more than 1 million visits are expected between now and the end of the series.

MEC Donates

Since the fall, MEC has been running an online promotion with *Alpinist* magazine. For every subscription sold online, MEC donates 5% of the revenues to the Canadian Avalanche Centre. In November MEC included *Gripped* magazine to the promotion. Again, 5% of all subscription revenues will be donated to the CAC. All MEC members are eligible for a 15% subscription discount to these magazines. To access this offer go to the "about members" section on the MEC Web site (www.mec.ca) and follow the links to membership discounts and benefits.

Thanks to MEC for their continued and thoughtful support of avalanche safety in Canada. What a great example of our partnerships!





Backcountry Avalanche Workshop Wrap

BY BARBARA ROSE

True to this year's theme ***Learn and Live!***, there was a whole lot of learning going on at the 2nd Annual Columbia Brewery Backcountry Avalanche Workshops held at the University of Calgary and Vancouver's Ridge Theatre on November 20th and 21st. Over the course of two days, a veritable "who's who" of avalanche professionals shared research knowledge and personal experiences with a captive audience of nearly 600 backcountry enthusiasts. With presentations covering the "10 Commandments" for safe travel, fracture "pops and drops," the "halo effect," risk management "throttles" and the new terrain classification systems, among others, attendees gained new knowledge and insight, and learned about new tools and techniques to help them better manage their avalanche risks. Many thanks to our presenters: Pascal Hägeli, Bruce Jamieson, Alan Jones, David Jones, Ian McCammon, Grant Statham, Bruce Tremper, Alec van Herwijnin and Clair Israelson.

> "Some of this information I learned today will only serve to help me to better prepare myself for safe travel." - Mark, workshop participant

The Workshops also proved the perfect backdrop to announce the formation of the Canadian Avalanche Centre (CAC), Canada's new national public avalanche safety organization (*Editor's Note: see pages 9 and 24 to learn more aboutnthe CAC*). Representatives from the National Search and Rescue Secretariat, Parks Canada, the B.C. Provincial Emergency Program, Meteorological Service of Canada and the Canadian Avalanche Foundation were on hand to celebrate their individual contributions to public avalanche safety and profile their collaborative efforts to raise public awareness and reduce avalanche accidents in Canada.

> *"(Ian McCammon's) talk alone was worth the drive." - Christine,* workshop participant

This year, many of our sponsors and partners showcased their products and services in mini tradeshows at both venues. Our thanks to Parks Canada, the Canadian Avalanche Foundation, CAATS, Kelley Sports, Backcountry Access, Mammut, Marmot, Arcteryx, MEC, Hestra and Deuter for taking part and also providing some great door prizes. A special acknowledgement to our title sponsor, Columbia Brewery, whose continued support of the workshops makes it possible to undertake this important public outreach event.

> "I was surprised and disappointed there were not more people in attendance." - Roger, workshop participant

Many of you have been asking for copies of speaker presentations. While we aren't able to reproduce the presentations, you can visit the links below for information on some of our speakers, their ongoing research activities and general avalanche safety information.

- *www.pc.gc.ca/pn-np/ab/banff/index_e.asp*
for Parks Canada avalanche information
- *www.eng.ucalgary.ca/Civil/Avalanche/papers.htm*
for avalanche research publications by the Applied Snow and Avalanche Research Group at the University of Calgary and collaborators

• *www.snowpit.com*
for Ian McCammon of Snowpit Technologies
• *http://www.avisualanche.ca*
for Pascal Hägeli.

> "I was in attendance at the Calgary session on Saturday and wish to thank you for the great effort!" - Rod, workshop participant

Overall, the program came off with few hitches and we received a lot of positive feedback on the presentations and workshop organization. The few complaints we heard were mostly concerned with overcrowding in the trade show area at the Ridge Theatre and audio problems at the Calgary site. Armed with all your comments, we're already planning for next year's event and intend to make it bigger and better than ever!

Finally, many thanks to the team of volunteers who helped out this year. With all the learning, let's hope there's a whole lot of living going on this winter in the mountains. Play safe and see you next year!

CAA and CSPS Team Up

Thanks to a donation of $10,000 from the Royal Bank of Canada Foundation of BC (RBC), the Canadian Avalanche Centre will be reaching out to teenagers to educate and encourage them to stay safe in avalanche terrain. To coordinate and deliver this program, the CAC has partnered with the Canadian Ski Patrol System (CSPS), an organization with an exemplary 35-year history of leadership in the development and delivery of winter public safety and accident prevention programs.

Peter Spear, a Life Member of the CSPS and a professional educator (now retired), has agreed to coordinate the project. Peter has been actively involved in avalanche education programs with the CSPS for 35 years and has already begun work on this initiative. Several school boards in BC and Alberta have expressed interest in avalanche education for their students, and the CSPS will work with them to provide materials and deliver training for teachers and other staff.

As part of this one-year pilot project, the CSPS will compile information from youth-directed avalanche education programs already established, such as SNOWSMART and "Snow." This material will be made available through computer links or other means. In May, 2005, the project's effectiveness will be assessed and recommendations made for future activities. Thanks again to RBC for their generous contribution to the future of avalanche safety.

Minutes of the ICAR Avalanche Rescue Commission

Conference, October 14 – 17, 2004 Zakopane, Poland

1. Welcome
   The Chairman welcomes 43 participants from 16 ICAR member countries to Zakopane and to the Avalanche Rescue Commission.
2. Information on procedures for papers, translation and presentation tools
   The decision was made to translate into German, English and French.
3. List of participants and country delegates of the Avalanche Rescue Commission (contact person for questions and data of that country).
   After a brief discussion the delegates to the Avalanche Rescue Commission were determined in writing. The Chairman has the list.
4. Minutes
   The minutes from Scotland (Fall 03) and Diavolezza (Winter 04) were accepted. These can still be found on the ICAR Web site under Avalanche Rescue Commission.
5. Strategy of ICAR; strategy and goals of the Avalanche Rescue Commission
   - 5.1. Briefing on the planned survey for the participants and delegates during the ICAR Conference 04.
     The briefing is held in front of the entire Delegate Assembly of ICAR.
   - 5.2. Written survey on the strategy, goals and business language of the Avalanche Rescue Commission.

   Of the 34 surveys handed out, 9 were returned to the Chairman by the end of the conference with comments and suggestions. Three more were promised. The results will be added to the evaluation upon receipt.
   In summary, the following can be made note of:
   - a) The tasks listed in the ICAR bylaws under 2.2., which apply to all commissions, were not questioned by anybody.
   - b) The 10 proposed goals for the Avalanche Rescue Commission were all approved (with only one opposing vote for point 5). The 10 goals mentioned, as well as some complimenting suggestions, are listed in a separate document, (Strategies and Goals for the ICAR Avalanche Rescue Commission starting 2005) ***Editor's Note:*** *the document follows on page 22.*

   The individual proposals will be briefly discussed at the next conference and then voted on.
   - c) All respondents mentioned the possibility to discuss exclusively in English. This would save an enormous amount of time. The question will be answered conclusively at the beginning of the next conference and the language(s) will be agreed upon.

6. Recommendations
   After a thorough discussion and following revision, the two proposal drafts were accepted in a joint vote of the Avalanche and the Terrestrial Rescue Commissions with one opposing vote. The delegates of the ICAR countries did not have any objections during the Delegate Assembly.

   The recommendations have the following titles:
   - Recommendation REC L 0004 of the Avalanche Rescue Commission of October 16, 2004 Regarding Avalanche Search Training with Buried People
   - Recommendation REC L 0003 of the Commission for Avalanche Rescue of October 16, 2004 Regarding the Marking of Locations on an Avalanche

   Both recommendations can be found on the Web page of the ICAR Avalanche Rescue Commission. An addendum to REC L 0003 was requested by France on October 22, 2004. The following comment should be added to the minutes (freely translated): "In France and in the Wallis (Switzerland), the locations of vague avalanche dog alerts are marked in orange."

7. Avalanche accident data collection / statistics
   The new form for avalanche accident data collection was introduced and distributed. The data from most of the participating countries has already been gathered. The missing data will be requested from the delegates by the Chairman. The current data is available in tabular form on the Internet.

   The poster and the paper titled "ICAR and its Role in Avalanche Rescue" that was coauthored by Hans-Jürg Etter and Roland Meister, SLF, Davos, Switzerland and Dale Atkins, CAIC, Colorado, USA, and presented at the ISSW in Jackson Hole in September 04 was issued in writing (incl. an evaluation of all the avalanche fatalaties in ICAR countries in the past 20 years).

8. Standards for (new) devices (radar, thermal imaging, etc.) to locate people who are not equipped with a transceiver.
   This topic had to be tabled due to the lack of time and will initially be discussed in writing amongst the delegates of the Avalanche Rescue Commission.

9. Information on the Internet

The Chairman pointed out the newly developed ICAR web site, which includes all the topics being discussed in the Avalanche Rescue Commission. It is the most current information source for all members throughout the year.

10. Proposals for the commission and 11. Proposals for the Board

There were no proposals.

12. Call for papers 2005 (topic, submission of manuscript or PowerPoint slides)

The main topic of ICAR 2005 in Italy will be the "lost person report and the search for lost people".

The Chairman recommends that presentations be registered by the end of August 2005 in order to be taken into account for the conference. (Please submit registered presentations to the Chairman one week ahead of the conference so that the translators can preview them.)

13. Miscellaneous

13.1. In order to make the Avalanche Rescue Commission more productive throughout the year as well as during the conferences, the Chairman suggests that Dale Atkins from the Colorado Avalanche Information Center in Boulder be elected as Co-Chair. Thesuggestion is approved by acclamation. Dale Atkins thanks everyone for the confidence and is willing to accept the task.

13.2. Dale Atkins speaks briefly about the paper and poster he presented at the ISSW in Jackson Hole. The title was: "Probing for Avalanche Victims". The paper was made available during the conference and can still be requested from Dale Atkins.

13.3. The interesting presentations shown during the joint sessions with the Terrestrial Rescue Commission and the lessons learned can be found on the ICAR Web site. Prior to adjourning, the Chairman thanks all the paricipants for their trust and active support.

President of the Avalanche Rescue Commission and recorder of the minutes
Hans-Jürg Etter
Davos, October 27, 2004

Strategies and Goals of the ICAR Avalanche Rescue Commission starting 2005

Compiled October 2004

The ICAR Avalanche Rescue Commission sees the following strategies and goals as its priority.

The commission shall:

1. Provide a platform to exchange experience and to discuss and learn from successful and less successful incidents and missions.
   Presentations shall be structured as follows:
   - Two to five keywords on the incident
   - A report of the event
   - Lessons learned
2. Promote detailed reports by rescuers on mission (e.g. with post-mission analysis of the scope and course of the mission). Search and rescue strategies aND emergency medical procedures can thus be improved.
3. Provide vendors with the opportunity to display safety and rescue equipment.
4. Provide the opportunity to present new technologies during the conference.
5. Further promote international investigation and verification of methods (e.g. warning systems for general dangers in mountainous areas and especially for avalanche danger). ICAR can play a coordinating role and offer to moderate such meetings.
6. Provide the possibility to present and discuss accident analyses made in individual countries. Comparisons of experiences from different countries may lead to new international insight on accident prevention and/or mountain rescue techniques.
7. Continue to publish and disseminate recommendations on rescue methods and preventative measures, which are agreed upon internationally. There have been many previous examples from the Commission for Alpine Medicine, the Air Rescue Commission, the Terrestrial Rescue Commission, as well as the Avalanche Rescue Commission.
8. Invite countries from overseas (e.g. Australia, China, Japan, New Zealand, South America, etc.) to participate. A written exchange of experiences can be a promising start – along the lines of a membership by correspondence.
9. Continue to make every effort possible to ensure that rescue missions can be run as safely as possible for the rescuers involved. Risk management must primarily entail the safety of the rescuers. (In the Past 65 years, 18 mountain rescuers were killed on avalanche rescue missions.)
10. Support an improved and optimized international data collection of search and rescue missions (with positive and negative outcomes). There is a justifiable conviction, that such data will provide new insights on accident prevention and allow rescue missions to be optimized.

There was also major consensus on the following issues:

- There is often too little time to accomplish everything during the annual conference. Members are coming from distant countries (e.g. North America, Scandinavia, or Bulgaria). The suggestion was made that the Avalanche Rescue Commission meet at the location of the annual conference, but maybe a few days earlier, if needed. This would only require one trip and would save both time and money.
- The agenda, along with the topics to be discussed, should be established well ahead of time so that the members can prepare themselves adequately.
- The Avalanche Rescue Commission of ICAR is the ideal venue to consolidate the different systems, methods, and strategies used in searching for and rescuing missing or buried subjects.

The following equally important issues were brought up as well.

The members of the Avalanche Rescue Commission shall:

- Briefly introduce themselves at the beginning of each conference (who they are, where they're from, whom they are affiliated with and in which capacity as far as avalanche and rescue work goes).
- Provide discussions and workshops in special interest groups using a common language, in addition to the general presentations.
- Use English as the common language.
- Require a 2/3 majority when voting on recommendations.
- Allow a total of 60 minutes per presentation, which shall include 40 minutes to discuss the material and exchange experiences.
- Host the conference and a workshop (for practical work) in alternate years.
- Not define standards but cover more EU and UIAA topics and inform the industry.
- Maintain and support the collaboration with the other commissions. The same rescuers are often also involved in terrestrial rescue and vice versa.
- Develop and present more case studies.

- Present training systems.
- Form special interest groups which cover certain topics throughout the year and present the results at the conference. Based on this preparation, recommendations can be completed quicker.
- Also discuss avalanche danger and forecasting.
- Develop standard tests for avalanche transceivers in collaboration with the manufacturers.
- Evaluate devices and search strategies and orient the manufacturers and the public.
- Identify trends in avalanche accidents. Incorporate the findings in avalanche awareness training and prevention.
- Only participate in joint presentations (with the Terrestrial Rescue Commission) if the topic is avalanche-related.

Additional comments:
Eight of the nine respondents would like to continue the collaboration with the Terrestrial Rescue Commission as is. The duration of the collaboration shall, however, be limited to mutually interesting presentations. The time saved can be used for further work within the Avalanche Rescue Commission.

Summary of responses as of October 27, 2004 /etr

International Avalanche Bulletin Writers' Workshop

BY GREG JOHNSON, CAC PUBLIC FORECASTER

The US Forest Service National Avalanche Center and the Canadian Avalanche Foundation hosted the second International Avalanche Bulletin Writers' Workshop and Information Exchange at the 2004 ISSW in Wyoming. The goal of the workshop was to bring a group of public avalanche forecasters together from around the globe to discuss how avalanche risk is communicated.

This year, 35 forecasters from the US, Canada, Switzerland, and Austria attended. Eight forecasters gave short presentations and led great discussions on a number of interesting topics. Alan Jones, the Canadian Avalanche Centre's Public Avalanche Warning System coordinator and Grant Statham, Avalanche Risk Specialist for Parks Canada, discussed new innovations in the way avalanche risk will be communicated to the public in Canada. Following the two large accidents that occurred in January and February 2003, funding for avalanche programs in Canada has significantly increased and some new philosophical approaches are being implemented. For this winter, Parks Canada rated their popular ski touring terrain using a new three-level terrain classification system. The Avalanche Terrain Exposure Scale (ATES) will help people choose an appropriate level of risk. In addition to the regular public avalanche forecasts, a new three-level picture-based avalanche advisory will be issued for all Canadian forecast regions. The media was involved in its development and they will disseminate the advisory in a similar manner to the way weather maps are presented. The idea behind the advisory is to provide basic information for people who have very little or no avalanche awareness.

Patrick Nairz, forecaster with the Avalanche Warning Center Tirol in Austria, discussed how different decision making tools from across Europe work. His presentation informed us as to why these tools were developed and how backcountry skiers use them. This was particularly interesting for Canadian forecasters, with a comprehensive research project underway in Canada to develop a similar tool.

In North America, many of us consider the Swiss Federal Institute to be a world leader in public forecasting and we always look forward to hearing about their practices and ideas. Avalanche forecasters Andreas Stoffel, Hans-Juerg Etter, Thomas Stucki and Christine Pielmeier gave short talks entitled: *10 Years of Experience With the 5-Level Danger Scale*; *One-Level Rule; the Experiences and Consequences*; *Tools in Danger Communication: Bulletin Interpretation Guide, Multilingual Glossary of Avalanche Terms, Snow and Avalanche Summary of the Current Week*, and *Warning Products and their Distribution Channels*. Their talks planted many seeds for how we can effectively build our avalanche programs.

Doug Abromeit, Director of the US Forest Service National Avalanche Center, gave the final presentation. He discussed the importance of workshops and forecaster exchanges. Last winter the Swiss Federal Institute and USFS had a formal exchange and both groups felt that they had benefited. In the coming years, exchanges between the Swiss, Americans, and Canadians will likely happen on an annual basis.

Throughout the ISSW week, I received positive feedback from the forecasters that attended. Many feel that our biggest challenge isn't the actual forecasting, but rather the way we communicate avalanche risk. After organizing a few of these events, it is amazing to see so many passionate people from different countries all struggle with the same issues of risk communication. We hope that these workshops provide a venue to discuss and help tackle these issues. Look for another workshop on registration day of the ISSW 2006 in Telluride.

Canadian Avalanche Centre – FAQs

What is the Canadian Avalanche Centre (CAC)?

A national not-for-profit corporation established to serve as Canada's public avalanche safety organization by:

1) Coordinating public avalanche safety programming
2) Providing public avalanche safety warnings
3) Delivering public avalanche awareness and education
4) Providing avalanche training for non-professional winter recreation
5) Serving as point of contact for public, private and government avalanche information,
6) Encouraging avalanche research

Why was the CAC created?

There was no federal, provincial or not-for profit organization mandated to provide public avalanche safety programs in the areas of Canada that are threatened by avalanches.

The CAC is an independent and politically neutral corporate entity with national scope, dedicated to public service, enabling federal, provincial, private and other not-for profit organizations to achieve common goals by pooling research and technical expertise, and financial or in-kind contributions.

The CAC provides a single point of contact for the Canadian public. CAC service delivery is designed so that all public avalanche safety programs can be accessed through one touch point.

In the past, the Canadian Avalanche Association (CAA) produced public avalanche bulletins and delivered other public avalanche safety services. Why the change?

The CAA was incorporated as a BC society in 1981 and as an Alberta society in 1983, and has no legal standing in the rest of Canada. In the past, the CAA's "public service" role was relatively small, and there was little demand for public avalanche safety services outside of mountain National Parks, BC and parts of Alberta. That's changing now and a federally incorporated CAC will be able to meet the growing demand for public avalanche safety services across Canada.

In the past, the CAA (in cooperation with National Parks and other partners) delivered national public avalanche safety programs and services because no other organization could. With the CAC assuming responsibility for "public service" avalanche programs for Canada, the CAA can now focus on what it does best — technical supports, training and other specialized services for workers and professional avalanche operations in Canada.

How is the CAC operated?

A great deal of care was taken to ensure the CAC is properly structured. The Ottawa-based Institute on Governance provided advice on governance, reporting and stakeholder relationships. Miller Thomson LLP provided legal advice and assistance with federal incorporation. BDO Dunwoody provided advice on financial structures and the business arrangements between the CAC and the CAA. There were extensive consultations with federal, provincial and other stakeholders to ensure the CAC is an efficient, effective and sustainable organization.

The CAC is governed by a Board of Directors drawn from the Canadian Avalanche Association, the Canadian Avalanche Foundation and CAC members.

The CAC operates from the CAA offices in Revelstoke. The CAC and the CAA share an Executive Director. Staff members are CAC employees, and are 100% engaged in public avalanche safety programs and services. Office space, administration and other support services are rented from the CAA at cost.

Through a Canadian Avalanche Roundtable, stakeholders will have input to CAC program planning, design and implementation, and receive scheduled reports on the achievements of the CAC. Federal and provincial agencies, private sector operators, outdoors clubs and groups, the academic community, and other not-for-profit organizations will participate in the Roundtable.

What about membership in the CAC?

One of the reasons for establishing the CAC was to create an organization so that people who are not professionally engaged in avalanche-related activities can become members, help with meaningful avalanche accident prevention work, and contribute financially. Under its bylaws the CAC has three categories of members: Friend (individuals), Supporter (businesses, agencies, clubs, groups), and Honorary Member (by invitation of the Board).

How can I contact the CAC?

Address:	Canadian Avalanche Centre 110 MacKenzie Avenue PO Box 2759 Revelstoke, BC V0E 2S0
Phone:	(250) 837-2435 / Fax (250) 837-4624
E-mail:	info@avalanche.ca / www.avalanche.ca

RAC Instructor Agreement

BY STEVE BLAKE

Who'd of thought it would create such a stir?

Many might answer, "I did!" For the Introductory RAC Course (IRAC) has been at least somewhat controversial from the start. Grumblings aside, the Recreational Avalanche Course program has been incredibly well received by students and instructors alike. Thousands of Canadians have been introduced to the concepts of recognizing and avoiding avalanche terrain and effective companion rescue techniques through recognized RAC providers.

So I ask again, who'd of thought it would create such a stir?

Bring on the grumbling. How could someone, an Affiliate Member of the CAA, a brand new "Level 1" graduate be considered qualified to lead a group into the mountains? From the beginning this question has been, and rightfully so, on the discussion table. The short answer, Canada is huge. The West is home to the bulk of Canada's avalanche expertise but what about the rest of the country? Avalanche deaths occur regularly in Quebec, the North, Newfoundland and Labrador. Even throughout Alberta and BC there are areas where suitably trained instructors are scarce.

In the end the benefits of widely available avalanche training, on a national scale, were deemed to outweigh the concerns. The decision was made. Affiliate members could in fact become IRAC instructors.

Advance the clock to the next century. Canada witnesses its worst year for avalanche deaths. *Avalanche* becomes a household word. And Canadian society expected to see some changes. In early 2004 the CAA's Education Committee (EdCom) put forward a recommendation in an effort to address leadership standards for IRAC providers. This was in response to, among other influences, our society's evolving risk tolerance.

Rather than change the instructor standard, why not create terrain restrictions for course delivery? This could solve this issue from the other side of the proverbial coin. The EdCom recommendation read like this:

"*The CAA only supports the delivery of Introductory RAC training in non-avalanche terrain. All course providers must accept full responsibility for their actions . . .*"

Keeping the courses out of avalanche terrain was the logic. In turn, instructor qualifications, from specifically a safety perspective, become no concern. Level 1 graduates are trained to "recognize and avoid avalanche terrain" making them, in this context, qualified to deliver IRAC programs.

But what of the instructors who exceed the minimum standards set out for IRAC, like Professional Members and mountain guides? Some assumptions were made, some discussion ensued, points and counter points were presented. In the end, the Recreational Avalanche Course License Agreement 2004 includes a Board of Directors' Approved Field Trip Policy for RAC Instructors. This continues to recognize Affiliate Members as "qualified" instructors but adds some terrain restrictions while recognizing Professional Members and the snow stability evaluation skills they bring to the table.

Board of Directors' Approved Field Trip Policy for RAC Instructors
A CAC field trip policy for RAC courses has been approved by the CAA/CAC board of directors, as follows:

- Instructors leading Introductory or Advanced RAC field trips assume full and sole responsibility for the care and safety of their students.
- Instructors leading Introductory or Advanced RAC field trips are responsible to ensure their activities are in full compliance with all regulations set by the managers of the land on which the field trip takes place.
- Instructors leading Introductory RAC field trips who are CAA Affiliate Members (Canadian Avalanche Association Training Schools - Level 1 graduates) are responsible to ensure those field trips take place on non-avalanche terrain only. Terrain inside ski area boundaries or on public roads open for public use is deemed to be "non-avalanche terrain".
- Instructors leading Introductory or Advanced RAC field trips who are CAA Professional Members (Canadian Avalanche Association Training Schools – Level 2 graduates) may choose to take those field trips onto avalanche terrain, provided that those instructors are in compliance with terrain guidelines set by all professional or certifying organizations that they are a member of.
- The CAC reserves the full and sole right to cancel the Instructors Agreement of any Introductory or Advanced RAC instructor found violating the terms and conditions of their Instructor Agreement.

Steve Blake is an Assistant Chief Park Warden for Jasper National Park. He is a fully certified mountain guide and has been dedicated to the park's public safety program for 10 years, five as the manager. He has worked at the Justice Institute of BC as a SAR Instructor/Coordinator and while sitting on the CAA Education Committee, Steve was responsible for the Recreational Avalanche Course (RAC) portfolio. He is currently Secretary/Treasurer of the Canadian Avalanche Association.

Explosives Report

Just to remind all members, the deadline for upgrading type 6 magazines (also called "day boxes") has now passed. Note that it is the responsibility of the owner of the type 6 magazine to carry out the modifications. However, even if you just rent such a magazine, you will still be considered out of compliance should the unit remain in use unmodified.

If your operation is using one of these magazines, it MUST comply with the following:

- Flimsy hinges, or those with removable pins, are not permitted. They should be replaced with a medium security type.
- Security lugs or a flange must be installed, if not already present, to the inside of the lid to prevent lifting of the rear of the lid if the hinges are cut or burned off.
- Magazines may no longer be restrained using a cable or chain. They must weigh at least 200 kg when empty or have a permanent internal tie-down through the bottom of the magazine to a suitable heavy base or directly to the ground.
- Padlocks must be from the new revised list. For instance, the popular Master 15 type is no longer allowed.
- Lock tabs must be changed to stainless steel (min ¼" thick). You may also need to enlarge the hoods covering the padlocks as the locks are larger than before. Hoods should be made deeper, if necessary, so that no part of the lock shows when attached.
- Existing wood/mesh laminate type 6 magazines cannot meet the revised standards and must no longer be used.

If you use only type 4 magazines (also called "walk-in"), BE AWARE they will be subject to a different set of modifications by May 31, 2006. Any questions regarding these upgrades can be directed to Terry Matts, Senior Inspector of Explosives, Natural Resources Canada (phone: 604-666-0366 or e-mail: tmatts@nrcan.gc.ca).

On another note, remember it is mandatory to report immediately any technical problems to your WCB explosives representative immediately. Any questions please contact the CAA Explosives Committee (e-mail: explodcom@avalanche.ca).

CAATS International

BY IAN TOMM

At the ISSW 2004 in Jackson Hole this September, the Icelandic Search and Rescue Association approached the CAA and asked for assistance in setting up a Ski Operations Level 1 training and certification program. Two senior CAATS instructors will be traveling to Iceland March 2-13, 2005 to work with the Icelandic SAR and Metrological organizations to run a seven-day CAA Ski Operations Level 1 course. We look forward to a long-term relationship with Iceland in meeting their future professional avalanche training needs.

CAATS is also traveling to Japan again this year. From January 18 to Feb 1, 2005, two representatives from the CAATS program will be traveling to Japan to run a Ski Operations Level 1 course, with the help of translators and members of the Japanese Avalanche Network (JAN). There will also be a three-day refresher course for all previous Level 1 graduates of the JAN Training School Ski Ops courses. The JAN has formally requested a Level 2 program for January or February of 2006 and a few days during this year's program will be devoted to working with a few members of Japan's avalanche community to develop a Level 2 program that specifically meets their needs. This development project will run over the summer of 2005 and we hope to have a summary of what the Level 2 program will look like for the fall 2005 edition of *Avalanche News*.

The CAATS program is dedicated to working with the international community. Not only do hosting countries benefit from the experience and quality of the CAA's programs and curriculum but the CAA also benefits from the exposure and experience in other countries. Look for a report on the Japan/Iceland experience at the spring AGM.

Events Schedule

January 14-16, 2005

Avalanche Awareness Days

"Learn and Live" at more than 35 communities across Canada and the US. Avalanche Awareness Days offer a mix of on-hill demonstrations, and gives the public a chance to ask questions of avalanche specialists while gaining information about avalanche safety in general. This year's national media event will take place at Lake Louise.

Contact: Janice Sanseverino, National Event Coordinator (canav@avalanche.ca)
Brent Strand, Community Event Coordinator (publish@avalanche.ca)

February 24 & 25, 2005

CAF Fundraising Dinners – Calgary and Vancouver

The Canadian Avalanche Foundation will hold benefit dinners and silent auctions in Calgary and Vancouver, both co-hosted by CAF directors Justin Trudeau and Chris Stethem. Guest speaker Scott Flavelle will share his experiences as Technical Director of the Eco-Challenge and describe the role Canadian guides played in staging the incredibly popular international adventure race series. A vintage Cadillac will be up for grabs at the silent auction in Vancouver. Dress at both events is business attire.

Where/When: Calgary Zoo Safari Lodge, February 24 / Vancouver Rowing Club, February 25.
Time: Cocktails at 6:00 pm, dinner at 7:30.
Tickets: $150. Receive a $75 tax receipt.
Contact: Tickets can be purchased through the CAF at (403) 678-1235 or E-mail: at info@avalanchefoundation.ca.
Last year's event was a sell-out so buy your tickets early!

April 11-14, 2005

Western Snow Conference 2005: Exploring New Frontiers in Snow Hydrology – 200 Years After Lewis and Clark

The North Continental Area of the Western Snow Conference is hosting the 73rd annual conference in Great Falls, Montana. This year, special emphasis is being placed on new technologies in the field of snow science, especially remote sensing.

Where: Heritage Inn, Great Falls, Montana
Info: www.westernsnowconference.org
Contact: Gerald Beard, North Continental Area Chair: jerry.beard@mt.nrcs.usda.gov

May 2-6, 2005

CAA Annual General Meeting and Spring Meetings

This year's CPD theme is *Professionalism at a Crossroads: Science, Technology and Common Sense.* A full day of ideas, discussion and debate on the avalanche profession in Canada and abroad is planned. Speakers to include: Ian McCammon, Bruce Jamieson, Pascal Hägeli, a risk specialist from the Calgary Regional Health Authority, and others still to be announced.

Where: Penticton, BC
Contact: Evan Manners, em@avalanche.ca.

June 10-12, 2005

CAF Golf Tournament

Tee off June 10th at the Canadian Avalanche Foundation's "Welcome to Summer Golf Tournament" in Kimberley, BC. Tournament guests will enjoy two nights accommodation at the Trickle Creek Residence Inn, a round of golf at the Trickle Creek Golf Resort and one round of golf at the Bootleg Gap Golf Course. All breakfasts and lunches, opening night reception, silent auction and banquet on the Saturday evening are included.

Where: Kimberley Alpine Resort
Info: Download a registration package at www.avalanchefoundation.ca
Contact: CAF office (403) 678-1235 for registration by April 30, 2005.

ISSW 2008

BY BRIAN GOULD

At the 2004 CAA meetings in Penticton, it was announced by Nic Seaton that someone needed to start planning for ISSW 2008. It would be Canada's turn in the six-year rotation of staging this significant conference. This was an open call for someone to step up to the plate. Upon this announcement the room fell silent (except for the sound of crickets). Who on earth would want to follow on the heels of one of the most well organized ISSW's ever – ISSW 2002 in Penticton? Well, we would – that's who.

The seed was planted that day at lunch as several West Coast CAA members sat together and started scheming. Five months and two seasons later, I found myself in Jackson Hole, at a lunch meeting presenting our bid to the ISSW steering committee and about 15 other interested individuals. Thanks to the help of 5 key volunteers (listed below), we were able to come up with a bid that no other competing venue could come close to matching (not that there were any other competing venues).

So it has been confirmed – Whistler is the official host of the ISSW 2008! The proposed date is September 21-26, 2008.

Although the conference is still almost four years away, planning is already under way. Sponsorship, field trip venues and accommodation options have been researched, and we are quite close to committing to the upscale Telus Whistler Conference Centre as the main conference facility. (They have recently completed a $10M renovation and now have state-of-the-art A/V technology to accommodate everything from WiFi capabilities, to a simulcast room, to webcasting. Although we expect to draw more than 700 attendees, there is room for many more should we need it.)

So with all this planning we will need a great deal of help. I have already communicated with a handful of interested people, but it is apparent that we will need people with varied skills and industry connections to make this a well organized event. If you have interest and/or skills in workshop/event planning, we would welcome your involvement. Even if you don't, a keen interest and your enthusiasm to help out will go a long way.

If you think this might interest you, please contact me at brian@hautealpine.com. In the next few months, I will be drafting an organizational structure for everyone involved.

I would like to thank the following volunteers for their efforts up to this point: Helene Steiner, Andrew Wilkins, Nadine Nesbitt, Dale Marcoux and Wayne Flann.

Thanks!
Brian Gould
CAA Professional Member

Coming soon:

Everything you ever wanted to know about Dr. J. How can someone be so smart and still look so cool? Just how many snowpits can one person dig in a winter anyway? And what does he do when he's not playing in the snow? Find out in the spring edition of *Avalanche News*.

Introductory Note: *The Recommendation below is the only structured approach to treating buried victims. Certainly avalanche professionals should be aware of the framework and may be the most informed on-scene if physicians or paramedics are not educated in avalanche rescue. Observing evidence of continued breathing (air pocket and free airway) in prolonged burial is emphasized. The Recommendation and its algorithm are based on the statistical review of many burials in Europe. Prospectively, the approach appears sound. The measurement of core temperatures is preferable in prolonged burials and professional and rescue organizations may consider adopting equipment to allow this. Likewise, if purchasing an AED the ideal is one that allows monitoring the cardiac rhythm (i.e. has a window showing the rhythm). The influence of devices such as the Avalung and ABS balloon on burials is unknown. After a prolonged burial the presence of a functioning Avalung that is not obstructing the airway may be an alternative to an air pocket/free airway. Likewise, an ABS balloon may allow expansion of the chest and prolonged survival if buried. I recommend that professionals be aware of this algorithm and forward it to other first responders, physicians and paramedics. It is freely available at the IKAR Web site at http://www.ikar-cisa.org/ . Jeff Boyd, IKAR MedCom, CMH Mountain Guide, <jbikar@telus.net>.*
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On-Site Treatment of Avalanche Victims ICAR-MEDCOM-Recommendation

HERMANN BRUGGER[1] and BRUNO DURRER[2]

INTRODUCTION

An avalanche accident is a medical emergency. In each decision, the goal of rapid rescue of the victim(s) must be balanced against the risks to the rescue team. The possibility of a second avalanche, snow conditions, and topographic and meteorological factors must be evaluated. *Thinking ahead* should be the guiding principle of the rescue procedure. Rescuers should bring emergency doctors and/or paramedics and dog handlers with dogs (“docs and dogs”) as soon as possible to the site of the avalanche. The more persons buried, the more doctors and/or paramedics needed. With a short burial time (up to 35 min), rapid extrication has absolute priority. If a buried person is in critical condition before 35 min, acute asphyxia or mechanical trauma is the most likely cause. In case of respiratory arrest, start artificial respiration as soon as possible during recovery. After a complete burial (head and trunk buried), hospitalize the patient for 24 hr to observe for pulmonary complications such as aspiration and pulmonary edema. After a prolonged burial time (more than 35 min), hypothermia is to be expected, and therefore extrication should be not as speedy as possible but as gentle as possible. An air pocket and free airway are essential for survival, therefore opon uncovering the face it is absolutely necessary to look for these. To date, a core temperature of 13°C can be assumed as the lower therapeutic limit for rewarming, but core temperature in this range has to be measured esophageally, because an epitympanic measurement can give false low values. Many clinicians reject a lower temperature limit on principle so as not to affect future therapeutic outcomes. Nowadays a nonlethal injury is no longer a contraindication for rewarming with cardiopulmonary bypass. If several buried persons must be attended to simultaneously, the maintenance of the vital functions of the survivors must have priority over resuscitation of buried victims without vital functions.

EQUIPMENT

Complete winter equipment includes a thermometer for core temperature measurement, hot packs (Table 1), and hot sweet tea. Consider an airway warming device to administer warm, moistened oxygen. If the outside temperature is low, make sure that transceiverbatteries are fully charged. If time permits, install a depot with a tent for medical care away from the avalanche site. Keep medicines and instruments (metallic laryngoscope) warm; for example, put a hot pack in the emergency physician’s bag and carry medicines against therescuer’s/physician’s body.

LOCALIZATIONANDEXTRICATIONOFTHEPATIENT

Get the emergency physician and/or paramedic to the scene after finding the victim’s position, rather than after rescuing the person. Watch for an air pocket (any cavity in front of the mouth and nose will suffice, no matter how

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This article reflects the consensus of opinion of the International Commission for Mountain Emergency Medicine, which has full responsibility for its content. It is intended for use by physicians and paramedics.

[1]Mountain Rescue Service provided by the South Tyrolean Alpine Association, President of the International Commission for Mountain Emergency Medicine.
[2]Emergency doctor of the Alpine Rescue Service, Swiss Alpine Club, Air Glaciers, President of the Medical Commission of the International Mountaineering and Climbing Federation.

small, provided the airway is clear). Avoid destruction of an existing air pocket during extrication! Do not dig vertically from above, but diagonally from the side in the direction of the buried victim. Absolutely avoid unnecessary movements of the victim's trunk and of main joints (shoulder, hip and knee). If movements cannot be avoided, carry the victim out as slowly as possible.

MONITORING

We recommend ECG monitoring during the entire time of rescue. Observe for provoked arrhythmia and ventricular fibrillation during extrication and removal. For core temperature monitoring, the auditory canal must be dry when using an epitympanic thermometer. Consider esophageal measurement in the lower third of the esophagus (preferable in hypothermia stages III and IV). Pulse oximetry can be disregarded because it results in wrong values due to peripheral vasoconstriction.

Staging of hypothermia

Swiss staging (Fig. 1) has the advantage that it can be established by nonmedical rescuers, because it is not based on measurement of the core temperature.

TABLE 1. PREVENTION OF HEAT LOSS IN ALL HYPOTHERMIA STAGES: INSULATION, HOT PACKS

Two to three chemical hot bags, one aluminum foil, two wool blankets, one cap are needed.

1. **Two to three chemical hot packs** near the heart on thorax and upper part of abdomen, not directly on the skin.
2. Before removing the patient, prepare the stretcher with **two wool blankets and aluminum foil.**
3. On removing the patient, **avoid big movements.**
4. Wrap up the patient closely packed in the blankets and in the aluminum foil.
5. **Cap** (30% to 50% of body heat is lost through the head).

ASSESSMENT OF THE PATIENT AND ON-SITE TREATMENT

The individual steps for assessment are shown in Fig. 1. All cases require core temperature and ECG monitoring, oxygen inhalation, and insulation in supine position. Consider airway warming. Only if an intravenous line can be established within a few minutes, 0.9% NaCl and/or 5% glucose can be administered. The administration of ACLS drugs, including epinephrine and vasopressin, is not yet recommended in hypothermia stages III and IV, because cardioactive drugs may have arrhythmogenic effects and can also accumulate to toxic levels. In stages I and II, ACLS drugs may be administered, but with longer intervals between doses than in normothermic patients. Trauma treatment is provided as indicated.

Patient alert or drowsy

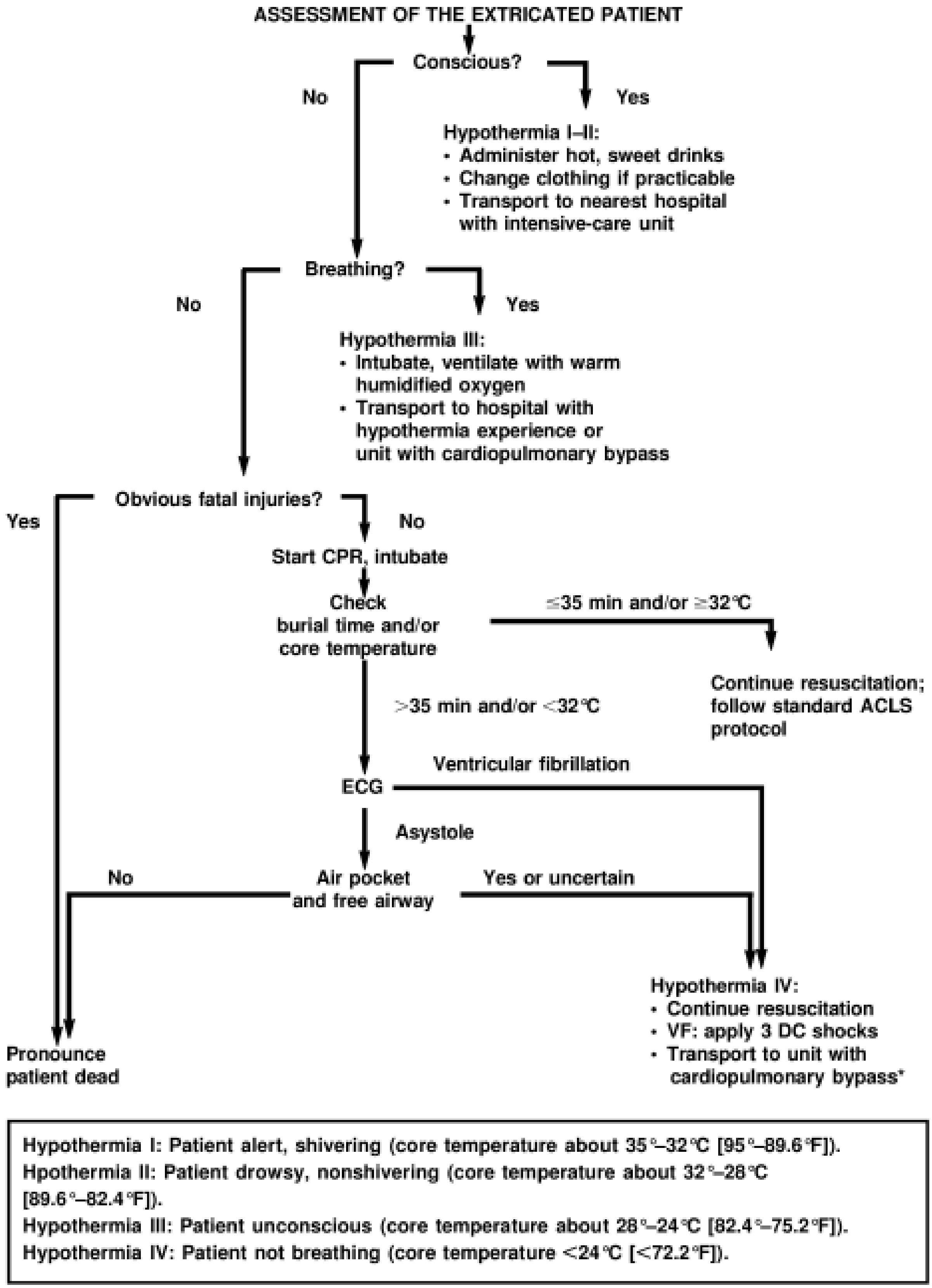
Change wet clothing without unnecessary movements (cutting is preferred). Hot sweet drinks are suitable as long as the swallow reflex is preserved. Transport to the nearest hospital with an intensive-care unit.

Patient unconscious

Whether a hypothermia stage III patient should be intubated at the site of the accident is still a matter of discussion. For intubation of a patient with protective reflexes, an intravenous line is needed for administration of medications. The risk of further heat loss during the time of treatment and transport has to be evaluated in relation to the advantages of intubation. Danger of provoked ventricular fibrillation with intubation is negligible. Transport to a hospital with an intensive-care unit and hypothermia experience or, preferably, a unit with cardiopulmonary bypass. Exclude obvious fatal injuries. Start cardiopulmonary resuscitation and intubate the patient. Check burial time and/or core temperature.

Asystole. Only the emergency physician should triage victims with asystole, in order to differentiate hypothermia stage IV from asphyxia. Bring patients with hypothermia stage IV to a hospital with cardiopulmonary bypass for rewarming. Criteria for rewarming include burial time, core temperature, air pocket, and airway. The emergency physician or the rescuer must provide the information about the air pocket and airway. Core temperature must be measured immediately after the rescue, because later measures are not reliable. The following situations are possible:

1. *Burial time ≤35 min and/or core temperature ≥32°C:* Continue resuscitation, following standard ACLS protocol. Successful: transport to the nearest hospital with an intensive- care unit. In case of failure the emergency physician can establish death by "acute asphyxia."
2. *Burial time >35 min and/or core temperature <32°C*
   a.) *Air pocket present and airway free (or uncertain):* Suspect hypothermia stage IV. Resuscitation must be continued without break until rewarming. Therefore, start cardiopulmonary resuscitation only from the moment when an uninterrupted resuscitation is possible. Use normal guidelines for cardiopulmonary resuscitation. Transport to a hospital with cardiopulmonary bypass, continuing cardiopulmonary resuscitation. If a unit with cardiopulmonary bypass cannot be reached directly by road or air, transport to the nearest hospital, continuing resuscitation, for determination of serum potassium (criterion of irreversibility). With values exceeding 12 mmol/L,



Brugger H., Durrer B. (2002). On-site treatment of avalanche victims.

FIG. 1. Algorithm for on-site management of avalanche victims. Staging of hypothermia according to Swiss Society of Mountain Medicine guidelines. *Transport to the nearest hospital for serum potassium measurement if hospitalization in a specialist unit with cardiopulmonary bypass facilities is not logistically possible (see text). Reprinted by permission of Elsevier from H. Brugger, B. Durrer, L. Adler-Kastner, M. Falk, and F. Tschirky (2001). Field management of avalanche victims. Resuscitation 51:7–15.

resuscitation can be stopped; with values of 12 mmol/L or less a further transport should follow (under constant resuscitation) for rewarming to a hospital with cardiopulmonary bypass.

b.) *No air pocket present and/or airway blocked:* The emergency physician can terminate the resuscitation and establish death "by asphyxia with subsequent cooling."

c.) *Ventricular fibrillation at core temperature <28°C:* Electric defibrillation is generally unsuccessful, but can be tried up to three attempts with 200, 300, and 360 J. Transport to a hospital with cardiopulmonary bypass under constant CPR.

ACKNOWLEDGMENT

This paper has been discussed and accepted 1998 (Fanes Hut, Italy) and 1999 (Sonthofen, Germany) by the International Commission for Mountain Emergency Medicine by the following members: Urs Wiget (president, Switzerland), Giancelso Agazzi (Italy), B. Aleraj (Croatia), J. Beaufort (Czech Republic), I. Bonthrone (Great Britain), S. Brandt (Italy), Fidel Elsensohn (Austria), M. Escoda (Andorra), G. Farstad (Norway), G. Flora (Austria), H. Forster (Germany), L. Hora (Rumania), H. Jakomet (Switzerland), D. Krassen (Bulgaria), X. Ledoux (F), B. Marsigny (France), I. Miko (Slovakia), J.R. Morandeira (Spain), J. O'Gorman (Ireland), W. Phleps (Austria), G. Rammlmair (Italy), P. Rheinberger (Liechtenstein), M. Swangard (Canada), D. Syme (Great Britain), I. Tekavcic (Slovenia), A. Thomas (Germany), and K. Zafren (USA).

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Jeff Boyd is an international mountain guide and an emergency physician. Raised in the deserts of Australia, Jeff did post-graduate research in physiology before taking up the guiding life. From professional avalanche control in Whistler, the trail led to CMH and the early development of their avalanche safety program. After a diversion developing the Emergency Medicine Program in the Banff Hospital, Jeff has re-discovered the mountains and guiding and combines his two personae by representing Canada on ICAR's Medical Commission.

Between a slab and a hard layer:
Part 2 - The persistence of poorly bonded crusts in the Columbia Mountains

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University of Calgary, Calgary, Alberta

Introduction

Wet layers on the snow surface that freeze become crusts, which are the bed surface for some slab avalanches (Fig. 1), a portion of which are difficult to forecast (Seligman, 1936, p. 308-310, 387). McClung and Schaerer (1993) stated that "weak bonding of snow above crusts is the most important feature of crusts with respect to avalanche formation." Because crusts are usually stiffer and harder than the overlying snow, they concentrate shear stress within the sloping snowpack and hence can contribute to shear failure at the upper boundary of the crust (Schweizer and Jamieson, 2001).

The first article of this three-part series focused on the formation of poorly bonded crusts, mostly due to faceting above wet layers and crusts. This second article summarizes field data from the Columbia Mountains regarding the persistence of layers of facets and surface hoar above melt-freeze crusts. In this series, wet or moist surface layers that freeze are referred to as crusts although they may be classified as frozen wet grains (WGcl or WGmf), rain crusts (CRrc), sun crusts (CRsc) or melt-freeze crusts (CRmfc) according to observation guidelines (CAA, 2002).

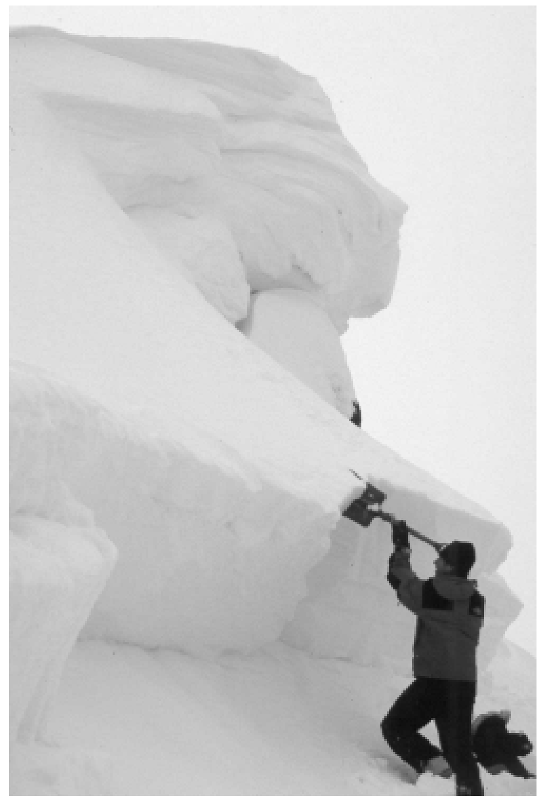

Fig. 1. Photo of an observer on 17 December 1996 at the crown of a natural dry slab avalanche in the North Columbia Mountains. The slab avalanche released in the facet layer on the rain crust that formed in mid November 1996.

Types of grains found on poorly bonded crusts

For natural avalanches in the Columbia Mountains, Haegeli and McClung (2003) reported that 17% released in facet layers on crusts, 6% released in surface hoar layers on crusts and 7% occurred on crusts without a weak crystal type reported on the crust.

From 1990 to 2004 in the Columbia Mountains, University of Calgary avalanche researchers and collaborators working mostly near Blue River and Rogers Pass have observed 335 detailed profiles near dry slab avalanches and "whumpfs"— where each whumpf is a fracture in a weak layer under a snow slab that did not release an avalanche (Johnson and others, 2001). The bed surface of 70 of these avalanches (including whumpfs) had crusts as the bed surface, implying the failure occurred in the overlying weak layer, and likely at the interface of the crust and weak layer where shear stress was concentrated. The primary grain types for the weak layers were: 39 layers of faceted crystals (FC), 23 of surface hoar (SH), one of depth hoar (DH), three of rounded grains (RG), three of decomposing and fragmented particles (DF), and one of precipitation particles (PP). All three of the weak layers of rounded grains had facets as their secondary (less evident) grain type. Grouping these three layers with the other layers of facets, we see that 94% of the weak layers included facets, depth hoar or surface hoar — the three grain types of weak layers known for their persistence in the snowpack (Jamieson and Johnston, 1992). This leaves four non-persistent weak layers: one of PP and three of DF particles. From weather records, the age of the PP and the three DF layers were 2, 2, 3 and 6 days on the day of the avalanche. Of the 39 facet-on-crust avalanches, the percentage of the facet layers less than 10 and 20 mm thick was 39% and 58%, respectively, indicating the importance of *thin* facet layers for slab avalanche release on crusts in the Columbia Mountains.

The age of layers that released slab avalanches on crusts is summarized in Figure 2 by grain type. Clearly, layers of facets or surface hoar on crusts remain potential failure layers on crusts much longer than layers of new snow forms or DF particles. The minimum, maximum, median and first and third quartiles of age were greater for facet layers on crusts that released avalanches than for surface hoar layers on crusts.

The size of surface hoar particles found on poorly bonded crusts

Since grain size as well as grain type likely affects the persistence of weak layers on crusts, let's look at particle size, starting with surface hoar layers on crusts that released avalanches. To graph the age of the layers, the burial date of the surface hoar layer must have been reported. This excluded some "patchy" surface hoar layers but included all widespread layers in the study areas. The average particle size ranged from 1 to 14 mm for these "dated" surface hoar layers on crusts when they released avalanches up to 32 days after burial. As shown in Figure 3, there is a trend for larger particles to be found in older failure layers. This is in spite of the tendency for the size of surface hoar particles manually taken from a particular layer to decrease over time (Jamieson and Schweizer, 2000). For layers with particles larger than 8 mm, the median age declines, perhaps because such large particles were less fragmented during extraction from the pit wall, as would be expected for recently buried layers. Where buried surface hoar overlies a crust, the surface hoar particles will be slow to penetrate the crust, delaying an important mechanism for strength gain of a surface hoar layer (Jamieson and Schweizer, 2000).

To look at a larger dataset of surface hoar layers on crusts, Figure 4 shows the age and average particle size for layers that fractured consistently in compression tests (= 30 taps). The age varies widely for any size of particles; however, the median age increases from 14 to 19 days for particles from below 2 mm to 8 mm. For this range of average particle size, the first and third quartiles of age also increase with particle size.

The size of faceted crystals found on poorly bonded crusts

Consider layers of facets on crusts. The oldest layers that released avalanches in this study (Fig. 5) were older (> 60 days) than the oldest surface hoar layers on crusts (32 days, Fig. 3). This reflects the documented persistence of some facet layers that formed on November crusts in the Columbia Mountains (Jamieson and others, 2001; Haegeli and McClung, 2003). Five of the failure layers consisted of rounded facets (Type FCmx) of average crystal size between 1.25 and 1.75 mm that had been buried for 13 to 22 days, showing the persistence of weak layers of rounded facets.

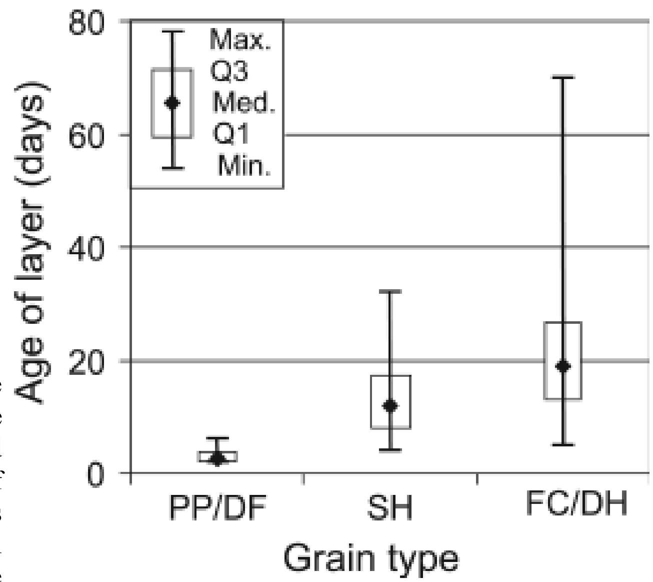

Fig. 2. Age of failure layers by grain type when they released dry slab avalanches on crusts. The filled diamond indicates the median age of the layers. The box includes the middle 50% of layer age and the whiskers indicate the full range of layer age. The layers of facets on crusts were often more persistent than layers of surface hoar on crusts, both of which were often critical longer than layers of new snow forms (PP) and DF particles on crusts.

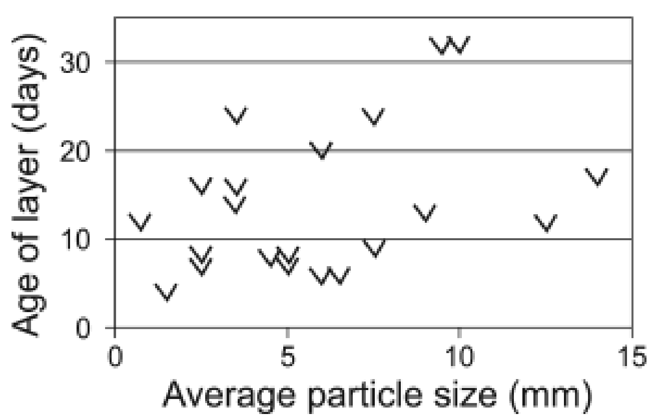

Fig.3. Age (since burial) and average particle size of 21 surface hoar layers on crusts when they released dry slab avalanches. Although there is considerable scatter, there is a general trend for the surface hoar particles to be larger in the older failure layers

To look at a larger dataset of facet layers that fractured on crusts, Figure 6 shows the age and average crystal size for layers that fractured consistently in compression tests. The median age of these layers increases to 67 days for crystals larger than 2.3 mm. The lack of data for facets (Type FCfa or FCsf) of average size less than or equal to 0.7 mm suggests their limited persistence as weak layers that fracture in compression tests. Since the bonds for small grains approach their maximum size much faster than larger grains (Colbeck, 1998), layers consisting of large grains are expected to gain strength much slower than layers of small grains. Also, there will often be fewer bonds per unit area at the failure interface because larger grains are typically farther apart than smaller grains. For average grain sizes less than 1.7 mm, Figure 6 shows little difference in the age of "sharp" facets compared to facets that exhibit signs of rounding (Type FCmx) when the layers fractured in compression tests.

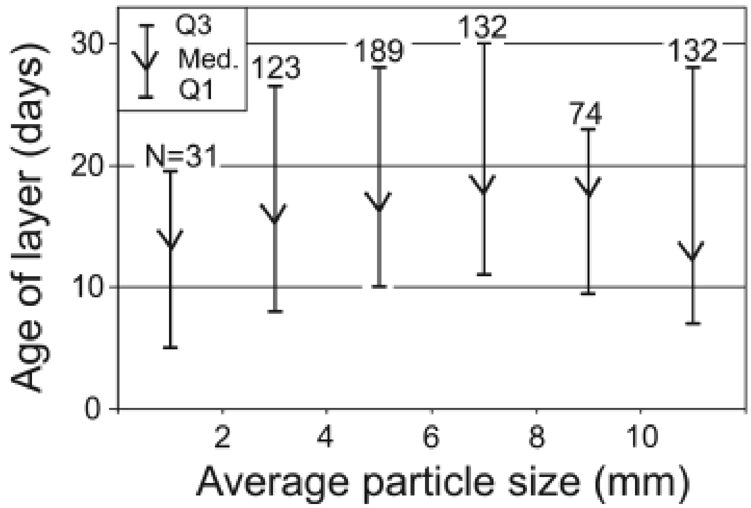

Fig. 4. Age of surface hoar layers (since burial) on crusts when they fracture consistently in compression tests (= 30 taps). For each range of particle size, e.g. > 2 mm and = 4 mm, the whiskers show the first and third quartiles of age and V indicates the median age. The number above the whisker indicates the number of layers each with unique location and/or date for which multiple compression tests yielded consistent fractures in the layer. The median age increases with average particle size up to 8 mm.

Summary

In these Columbia Mountain observations, facets and surface hoar were found at the interfaces of many poorly bonded crusts, including almost all of those that released dry slab avalanches more than three days after the weak layer on the crust was buried. Although the size of particles from surface hoar layers that released slab avalanches on crusts were usually larger than for facet layers on crusts, the facet layers often remained potential failure layers for longer.

The persistence of weak layers of facets and of surface hoar on crusts increased with grain size. Based on limited data from dry slab avalanches, rounded facets up to 1.7 mm showed comparable persistence to sharp facets of similar size. In more abundant observations of fractures in compression tests, a similar trend was observed. Although rounding of facets is often considered evidence of increased bonding, an increase in stability is not apparent in these observations for layers of rounded facets less than 1.7 mm compared to sharp facets of similar size.

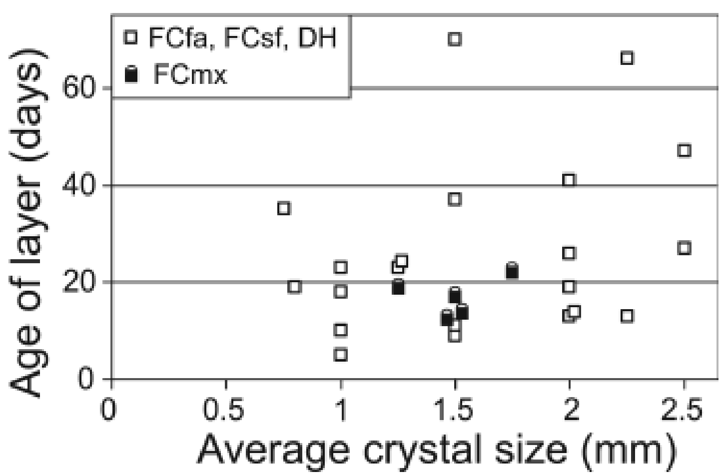

Fig. 5. Age and average crystal size of 26 layers of faceted crystals on crusts when they released dry slab avalanches in the Columbia Mountains. The open squares represent layers of "sharp" facets (FCfa, FCsf) including one layer of depth hoar (DH). The filled symbols represent layers of rounded facets (FCmx). Although there is considerable scatter, the oldest failure layers tend to have larger crystals than younger failure layers.

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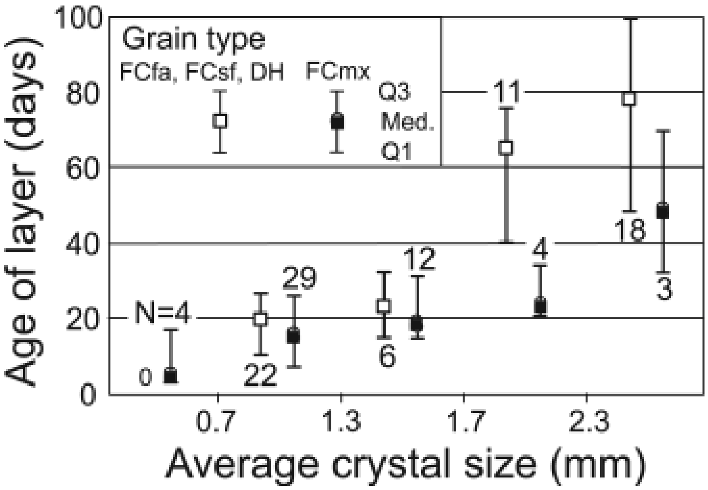

Fig. 6. Age of a facet layer (since burial) on crusts when the layer fractured consistently in compression tests. For each range of particle size, e.g. > 0.7 mm and = 1.3 mm, the whiskers show the first and third quartiles of age. The open squares represent the median age of layers of "sharp" facets (FCfa, FCsf) or depth hoar (DH). The filled symbols represent the median age of layers of rounded facets (FCmx).

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Avalanche Winter Regimes – A System for Describing Avalanche Activity Characteristics

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Summary:

Snow climate terms, such as continental and maritime, are often used by professionals for discussing the avalanche characteristics of a specific region or debating the avalanche activity observed during a particular winter season. Existing snow climate classifications rely heavily on meteorological parameters that describe the average weather during the main winter months. Field experience and measurements, however, show that the character of snowpack weaknesses including their type structure and details of formation are the primary indicators of avalanches that form. Such characteristics are not a formal part of any snow climate classification scheme. Therefore, such classifications can only be of limited use for avalanche professionals.

The focus of this study is the analysis of persistent snowpack weaknesses in Western Canada. Observations from the industrial information exchange (InfoEx) of the Canadian Avalanche Association are used to examine the frequency, sequence and distribution of the most common snowpack weakness types and their related avalanche activity. The results show significant temporal and spatial variations, even in areas with the same snow climate characteristics. The transitional Columbia Mountains, for example, exhibit snowpack weakness characteristics that clearly go beyond a simple combination of maritime and continental influences. 'Avalanche winter regime' is suggested as a new term to describe and classify local snow and avalanche characteristics that are directly relevant for avalanche forecasting. Three preliminary avalanche winter regimes are identified for Western Canada.

1. Introduction

The three main snow climate types, maritime, continental and transitional (McClung and Schaerer, 1993) are well established and have been used in many snow and avalanche related studies. While the maritime and continental snow climates represent the two extreme values of the spectrum, the transitional type exhibits intermediate characteristics. A detailed historical review of the development and usage of these terms in North America is given in Hägeli and McClung (2003). Snow climate classifications are heavily based on meteorological parameters. The most recent classification method (Mock and Birkeland, 2000), for example, focuses on the main winter months December to March and uses mean air temperature, total rainfall, total snowfall, total snow water equivalent and a derived average December snowpack temperature gradient to classify the local snow climate.

Even though LaChapelle (1966) described the average avalanche characteristics expected in the different climate regions, this type of classification can only provide little information for operational avalanche forecasting purposes. Field experience and measurements show that the character of snowpack weaknesses including their type, structure and details of formation are the primary indicators of avalanches that form. While existing classifications focus on average winter weather characteristics, snowpack weaknesses are created by sequences of specific weather events. Such characteristics are not a formal part of any snow climate classification scheme.

The goal of this study is to examine snowpack structures that are directly relevant for operational avalanche forecasting. While new snow avalanches are common in all mountain regions and can generally be correlated to individual storm cycles, it is the frequency and characteristics of avalanches related to persistent weaknesses that most often distinguish different regions for avalanche forecasting purposes. Avalanche and snowpack observations from the industrial information exchange (InfoEx) of the Canadian Avalanche Association are used to examine the frequency, sequence and distribution of the most common snowpack weakness types and their related avalanche activity in Western Canada. An 'avalanche winter regime' is suggested as a new classification term to describe the avalanche characteristics of a winter in a particular place. In this initial analysis three distinct avalanche winter regimes are identified for Western Canada.

2. Data Set

Western Canada is an ideal area for studying avalanche winter regimes. The three main mountain ranges, the Coast Mountains, the Columbia Mountains and the Rocky Mountains, cover a wide range of different snow and avalanche conditions (Figure 1).

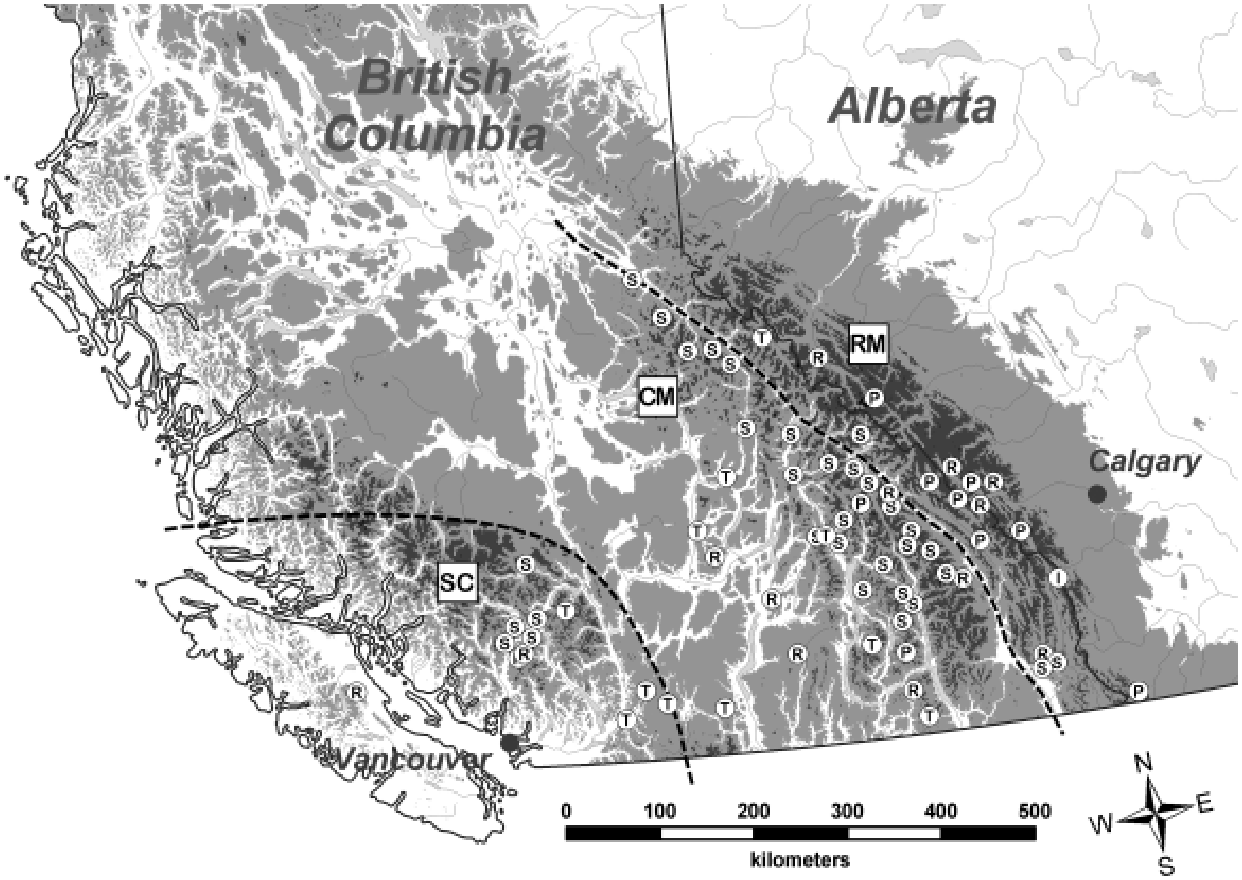

Fig. 1: Main mountain ranges of the study area (SC: Southern Coast Mountains; CM: Columbia Mountains; RM: Rocky Mountains) and type and locations of operations contributing to InfoEx service (I: logging and mining operations; P: national or provincial parks; R: resort; S: backcountry skiing operation; T: highway and railway operations).

This study focuses on the analysis of avalanche and snowpack observations of the InfoEx dataset from the winter seasons 1996/97 to 2001/02. The data quality and coverage regarding snowpack weaknesses prior to 1996 is too marginal to be included in a climatological analysis.

At this point it should be pointed out that operational avalanche datasets are inherently incomplete and skewed. Avalanche information is incomplete due to observational difficulties, such as large operation areas or poor visibility (Hägeli and McClung, 2003; Laternser and Schneebeli, 2002) and snowpack observations may be skewed by the practice of targeted sampling (McClung, 2002).

The spatial patterns observed are strongly influenced by the distribution and type of submitting operations. Different regions of the study area are dominated by different mixtures of contributing operation types (Figure 1), which can introduce a significant observational bias to the data. Each operation type has different operational priorities and observational capabilities. Mechanized backcountry operations, for example, mainly deal with the undisturbed snowpack, are concerned with skier triggering and cover large areas of terrain. Highway operations, on the other side, generally focus on areas directly threatening the road and frequently use explosives for avalanche control. These operational differences clearly affect the information submitted to the InfoEx.

All these observational biases have to be kept in mind when examining the dataset. Despite these biases, the operational usage of the dataset makes us confident that the recorded data had direct relevance to avalanche forecasting at the time.

3. Method

It is a common industry practice to label important snowpack weaknesses with their date of burial. This convention allowed the tracking of these weaknesses in the InfoEx dataset throughout a season.

The focus of this study is on persistent snowpack weaknesses (Jamieson, 1995). We defined the cut-off between persistent and non-persistent to be ten days after burial, which is distinctly longer than one meteorological synoptic period. Related snowpack and avalanche observations that were made after the cut-off are commonly referred to as 'persistent observations' or 'persistent avalanche activity'. We also distinguish between 'active' and 'inactive' areas of snowpack weaknesses. An area is considered active if locally more than one operation recorded related avalanche activity and the reported avalanches were not exclusively triggered by explosives. Persistent active areas have to exhibit consistent avalanche activity more than ten days after burial.

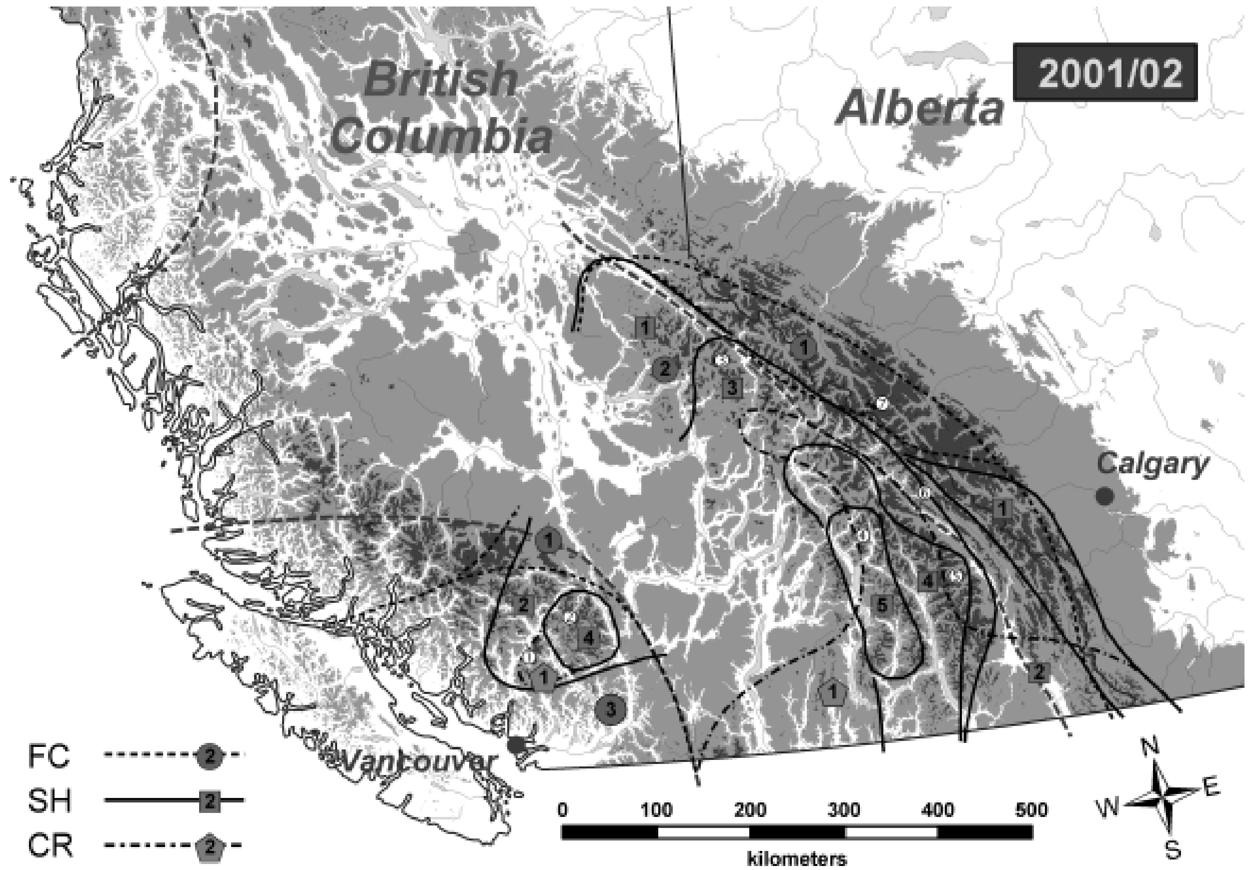

Fig. 2: Distribution of persistent snowpack weaknesses observed during the 2001/02 winter season (FC: weaknesses of faceted grains including facet-crust combinations; SH surface hoar layers; CR: pure crust interfaces). The big labels indicate the number of observed weaknesses. Small numbers indicate representative locations of regions of similar snowpack weakness characteristics.

This definition of persistence is different from the ones used in previous studies. Jamieson's classification (1995) was purely based on weak layer crystal types, while Hägeli and McClung (2003) used snowfall data to directly determine the synoptic period and distinguish between non-persistent and persistent weaknesses. The data at hand do not permit the use of one of these more advanced definitions. However, the method used in this study does identify all significant persistent weaknesses mentioned in existing studies (e.g., Hägeli and McClung, 2003; Jamieson et al., 2001).

For the analysis, the observed snowpack weaknesses were grouped into three main categories according to the study of Hägeli and McClung (2003). The three groups are: (a) weaknesses with faceted grains including facet-crust combinations (see, e.g., Jamieson and Johnston, 1997); (b) surface hoar layers; and (c) pure crust interfaces. Together, these three groups cover approximately 95% of all avalanches with reported weak layer information in the InfoEx. The remaining 5% of avalanche are mainly related to precipitation particles and decomposing fragments.

To examine the characteristics of individual observed weaknesses, maps were produced that show the spatial distribution of related persistent snowpack observations and avalanche activity observations. Based on these spatial patterns, seasonal contour maps were produced that show the number and distribution of the three groups of persistent weaknesses across the study area (Figure 2). The same type of map was also used to examine the seasonal patterns of areas with persistent avalanche activity.

Despite significant variabilities in snowpack weakness patterns from season to season, consistent patterns of frequency and composition were found across the study area. The limited number of winters with consistent avalanche observations (1996/97 to 2001/02) analyzed in this study, however, did not allow a reliable delineation of climatological regions of different snowpack weakness characteristics. Instead, seven locations were identified to adequately represent the different regions (Figure 2).

To analyze the seasonal variations of snowpack weaknesses in more detail, idealized snow profiles were constructed for each of the chosen locations (Figure 3). These profiles present the sequences of observed active and inactive weaknesses in the different areas represented by the locations. On the basis of the six winters analyzed in this study, climatological snow profiles were generated for each location. These climatological profiles show average numbers of active and inactive snowpack weaknesses. The succession of weaknesses reflects the general sequence observed during the seasons analyzed. Profiles of individual winters were compared to these climatological profiles to examine annual variations in the weakness patterns.

Annual variabilities were also examined with respect to classical snow climate classifications. A detailed description of a snow climate analysis for Western Canada is beyond the scope of this paper. The analysis was done according to Mock and Birkeland (2000) and is described in detail in Hägeli (2004).

4. Results

The results are presented by first describing the observed weakness patterns of an individual season. Regions of similar characteristics are identified and spatial and temporal variabilities are examined with respect to traditional snow climate classifications.

4.1 Season 2001/02

We use the records of the 2001/02 winter season to illustrate seasonal snowpack weakness patterns (Figure 2). Other seasons examined in this study exhibit similar patterns. In general, individual persistent weaknesses are widespread and observed across significant parts of the study area. While the number of layers with faceted crystals is fairly constant across the entire area, the number of surface hoar layers varies considerably among different regions. The Southern Coast Mountains can be separated into a western and an eastern section. The dryer eastern part exhibits more surface hoar weaknesses than the western counterpart. The Columbia Mountains show the highest number of persistent surface hoar layers with a maximum occurring on the western side of the central Selkirk Mountain Range. The number of surface hoar weak layers drops from west to east and toward the northern and southern parts of the Columbia Mountains. The Rocky Mountains can also be divided in areas with different snowpack weakness compositions. The section west of the continental divide is clearly more similar to the eastern parts of the Columbia Mountains with a higher number of surface hoar layers, while the rest of the range rarely experiences persistent weaknesses of this type. The analysis suggests a possible north-south division of the Rocky Mountains. However, the division cannot be demonstrated conclusively with the data at hand.

While persistent weaknesses are generally widespread, the regions where these weaknesses lead to persistent avalanche activity are considerably smaller (Hägeli, 2004). The avalanche activity patterns observed, however, generally support the spatial patterns discussed above.

4.2. Climatological snow profiles

The analysis of the spatial patterns of persistent weaknesses and related avalanche activity of all seasons suggests that the study area can be divided roughly into seven different regions. Each of these regions exhibits different average snowpack weakness and avalanche activity characteristics. The following locations were chosen to represent the different regions (Figure 2):

1) Whistler Area (representing western parts of the Southern Coast Mountains)
2) Duffy Lake (eastern slopes of Southern Coast Mountains);
3) Cariboo Mountains (northeastern Columbia Mountains)
4) Central Selkirk Mountains (central western slopes of Columbia Mountains)
5) Purcell Mountains (southeastern Columbia Mountains)
6) Yoho National Park area (western Rocky Mountains)
7) Columbia Icefield (Rocky Mountains east of continental divide).

Figure 3 shows idealized snow profiles for the different regions and seasons. The climatological profiles that represent average conditions for the different regions are shown on the bottom left of the figure.

Early season layers of faceted layers are observed in all areas and occasional pure crust layers predominantly occur in the Coast Range and the central Selkirk Mountains. The climatological profiles confirm that the number of surface hoar layers can be used as a distinguishing factor between different regions. The central Selkirk Mountains clearly experience the highest number of active and inactive surface hoar layers. While, on average, there are no significant surface hoar layers observed on the eastern slopes of the Rocky Mountains, the Coast Mountains experience the occasional surface hoar weakness. In addition to this variation in the west-east direction, the observations also show a decrease of persistent surface hoar layers towards the north and south within the Columbia Mountains.

Even though the dominance of early-season faceted layers in the Rocky Mountains is in agreement with the generally weak foundation of the snowpack in this region (McClung and Schaerer, 1993), it is rather surprising that depth hoar does not emerge as a primary weakness in the data. We suspect this to be an artefact of the reporting system, since depth hoar layers cannot easily be associated to specific burial dates.

4.3. Seasonal variations in snowpack weaknesses

Winters that exhibit similar snowpack weakness characteristics to the climatological average are 1999/00 and 2001/02. These two winters also exhibited average winter weather characteristics (Hägeli, 2004). In comparison to other winters examined in this study, the January 8, 2002, weak layer of faceted grains clearly stands out as a peculiarity of that season. This is in agreement with the rain-on-snow analysis by Hägeli and McClung (2003), which showed that these events primarily occur during the early months of the winter season. The season 1997/98, which was also classified as a regular snow climate winter in Hägeli (2004), was characterized by the absence of an active early season weak layer of faceted grains. The analysis of these three winters already shows that significant snowpack differences can be observed among winters with similar average weather characteristics.

This variability is even more pronounced in the more maritime winters of 1996/97 and 1998/99 (Hägeli, 2004). The first season was dominated by the November 11, 1996, facet-crust combination, a small number of surface hoar layers and numerous crust interfaces during the main winter months. The 1998/99 winter, on the other side, was characterized by an average number of surface hoar layers in the Columbia Mountains. However, the majority of them did not result in persistent avalanche activity.

The only winter with a more continental snow climate influence in the study, 2000/01 (Hägeli, 2004), is characterized by an average number of persistent weaknesses in the Columbia Mountains. In comparison to the climatological average, however, only a small number of these persistent weaknesses were active. The Coast Mountains experienced an exceptionally large number of persistent surface hoar interfaces and weak layers during this winter. No persistent interface and weak layers were reported in the Rocky Mountains.

While the continental winter does show a shift of the maximum number of surface hoar layers towards the Coast Mountains, no east-west shift of the climatological patterns seems to exist during more maritime winters. We suspect that the main reason for the absence of surface hoar weaknesses in the Rocky Mountains is the very low humidity in the region. Even a stronger maritime influence cannot provide enough moisture to create persistent surface hoar weaknesses in this region.

4.4 Avalanche winter regimes

'Avalanche winter regime' is suggested as a new term for describing and classifying the characteristics of local avalanche activity. This classification should contain detailed information about the characteristics of expected avalanche throughout a winter in a given area.

The present study focused on persistent snowpack weaknesses and their related avalanche activity. Within the study area, the analysis revealed three distinct regimes regarding persistent weaknesses. The Whistler area experiences approximately three to four significant persistent weaknesses per season. They are mainly pure crust interfaces. The

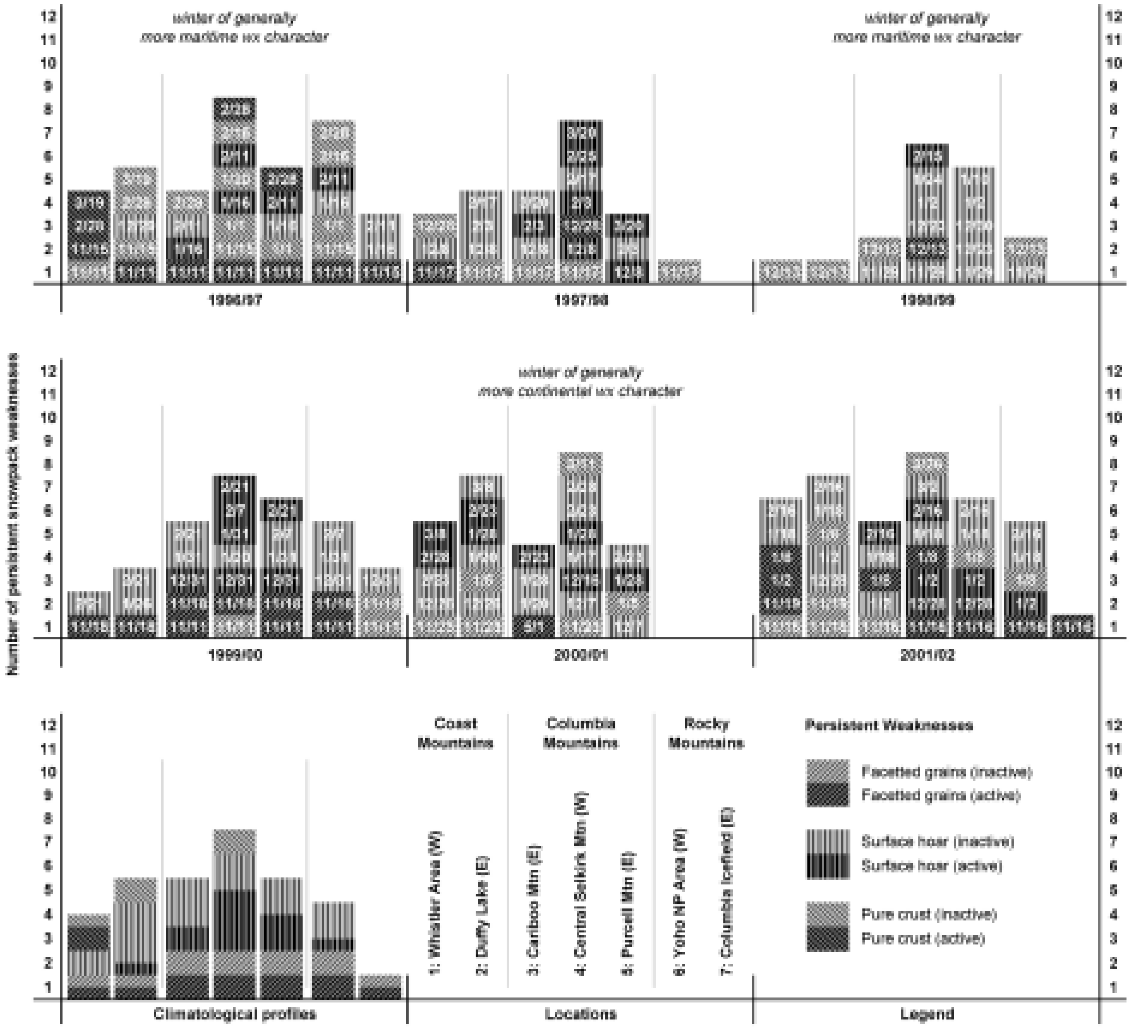

Fig. 3: Idealized snow profiles for the seven locations representing different snowpack weakness regions. The weaknesses are labeled with their burial date. The three different types of weaknesses are indicated by different background shading. Active weaknesses are indicated by dark shading, while inactive weaknesses are shown in light shading. Snow climate classifications of individual seasons are discussed in detail in Hägeli (2004).

avalanche winter regimes of the central Selkirk Mountains are dominated by an early-season facet-crust combination and numerous surface hoar layers. With about seven per year, this area exhibits the most persistent weaknesses within the study area. The region represented by the Columbia Icefield is characterized by generally only one persistent weak layer of faceted grains or potentially depth hoar per season.

The snowpack weakness characteristics of the other regions show intermediate properties that can be interpreted as combinations of these three regimes. The idealized snow profiles show that the local avalanche regimes can vary from season to season depending on the dominating processes, similarly to snow climate characteristics.

5. Conclusions

The analysis of persistent weaknesses clearly showed that the transitional Columbia Mountains have very distinct avalanche activity characteristics that clearly go beyond a simple combination of maritime and continental influence. Even within the mountain range, considerable variabilities were observed. The analysis of the different winters also showed that there is significant variability in the composition of snowpack weaknesses even during years with similar average winter weather. Particularly, the two more maritime winters experienced dramatically different profiles.

All these results emphasize the conclusion that the snow climate classification is inadequate for capturing the characteristics relevant for describing the avalanche activity of a region effectively. We suggest 'avalanche winter regime' as a new term for describing and classifying the local characteristics of the expected avalanche activity. This classification should contain detailed information about the characteristics of expected avalanche throughout a winter in a given area.

research

The present study focused on persistent snowpack weaknesses and their related avalanche activity. Within the study area, the analysis revealed three distinct avalanche winter regimes. Other regions exhibit intermediate characters.

Persistent weaknesses are clearly only one of the aspects that determine the characteristics of an avalanche winter regime. This study can only be seen as a first step in the direction of a process-oriented definition of avalanche winter regimes. More winters with consistent avalanche activity data are needed to expand the description of the different regimes by including more relevant parameters and identifying the underlying processes. To do so, more high-elevation meteorological observation sites are necessary to better characterize the local sequence of weather events and to conclusively explain the observed large-scale avalanche activity patterns. Meteorological indicators, such as the clear-night-cold-day index used in Gruber et al. (in press) or the potential for facet-crust combinations of rain-on-snow events (Hägeli and McClung, 2003) might provide means to identify and describe different avalanche winter regimes. Similar studies in other geographic regions, particularly in regions with transitional snow climates, are necessary to identify additional avalanche winter regimes and to generalize the regime types found in Western Canada. The results of this research will lead to a set of process-oriented avalanche winter regime definitions that can be used to classify local avalanche characteristics. The resulting regions will provide natural forecast domains, which will lead to improved quality and delivery of large-scale avalanche forecast products, such as the public avalanche bulletins and industrial information exchanges, such as the InfoEx.

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Small-scale mapping of snow stability: If not, why not?

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Introduction

Lately, there has been considerable interest in creating high resolution maps of current or short term avalanche hazard, danger or risk for backcountry recreationists. Maps of individual bowls, or even slopes, showing areas of high, moderate and low hazard with different colours or shading have been proposed. Some of the advantages or the appeal of this type of small-scale mapping include:

1. There is great interest in knowing where the more or less stable areas are.
2. Colour coded maps or images are very effective communication tools.
3. Technology, like geographic information systems (GIS) and the Web, are creating important communication opportunities.

With the recent advances in GIS and terrain data, a reasonable approach to creating such maps is with the help of digital elevation models (DEMs). At their current resolution, slope angle, elevation and aspect data can be reasonably estimated for cells of 20 m by 20 m, but the accuracy of slope angle estimates is of concern. These high resolution terrain attributes could then be combined with snow stability information from a central location to model the hazard, danger or risk for each 20 m pixel in the neighboring terrain. Current or near future estimates of snow stability can be used to produce maps for different time steps into the future.

The big question that comes to mind is whether this mapping can be done to a degree of accuracy that is useful for practitioners and recreationists. There have been opinions that this can't be done effectively at this point in time. In this article we try to answer the question "if not, why not?" Discussions of this question at the Avalanche Visualization Workshop during the CAA Annual General Meeting in May, 2004, focused on *spatial scale issues* as the principal underlying topic. In order to provide a complete answer we first need to introduce some terminology and fundamental concepts.

Spatial scale refers to the characteristic length of a *process* (e.g. snowpack property), *measurement* or *model* (Blöschl and Sivapalan, 1995; Hägeli and McClung, 2001). While the length scale of a process or phenomenon depends on the natural characteristics of the underlying processes, the scale characteristics of measurements and models are a function of their design. For example, synoptic weather systems have typical length scales on the order of 100 to 1000 km. Weather observation stations and computer models have been designed at scales that allow an approximation of the characteristics of this natural system, and weather is generally forecasted with reasonable accuracy. Our goal is very similar: We would like to take snow stability, measure it adequately and model it across the neighbouring terrain in the form of maps. Unfortunately, it is often not possible to measure and model a phenomenon at its natural scales and it becomes necessary to transfer information across scales. This process is generally referred to as *scaling,* and *scale issues* are the difficulties that arise when dealing with scale and scaling (Blöschl and Sivapalan, 1995; Hägeli and McClung , 2001; Hägeli and McClung, in press). The two main scale issues with respect to small-scale mapping of snow stability are (a) matching the observational and model scale with the natural scale of snow stability; and (b) transferring information across scales when it is not possible to match observation and model scales to the true process scale.

One thing to consider when evaluating the usefulness of these maps is the *signal-to-noise* ratio (S/N), often used in image analysis. The S/N is the ratio of signal strength to noise strength (or the unexplained signal variability). High S/N ratios are ideal, but with increasing noise the ratio decreases and becomes one when the noise is as strong as the signal. Campbell (2004), for example, was unable to explain the variability in snow stability observed on many slopes using arrays of rutschblock tests. In other words, the S/N was low. This was probably due to an inadequate number of tests (weak signal) to distinguish between the multiple underlying processes (strong noise) that act on stability. The acceptable S/N probably depends on many factors but after discussions with John Poole, Jeff Thurston and Ilya Storm it became apparent that the acceptable S/N depends on the application and user. Any considerable amount of noise on a map intended to guide the public in safe route selection is unacceptable since it might be easily be misinterpreted with potentially high consequences.

Scale issues are strongly debated in many geosciences. In many disciplines the focus is on averaged and integrated variables, such as the stored snow water equivalent in an entire watershed in snow hydrology. The averaging process takes care of many scale issues and improves the signal-to-noise ratio. In snow stability, however, we are interested in variabilities on very small scales (Schweizer et al., 2003). This requires detailed point-to-point extrapolation and interpretation of individual observations, which does not improve the initial S/N of the data. While avalanche professionals have developed successful strategies to deal with this complexity, it is highly challenging to address this issue in models.

Process scales

Table 1 lists some commonly used spatial process scale descriptions. Snowpack properties, including stability, can vary significantly at the slope-scale (Campbell, 2004; Kronholm, 2004; Stewart, 2002) and even at the study plot-scale (Landry et al., 2004). Varying slab thickness and slope angle have been shown to be possible sources of variability in rutschblock scores across some avalanche start zones (Campbell, 2004; Campbell and Jamieson, 2004). However, using slab thickness and slope angle alone to predict stability is impractical because point stability across most start zones did not show correlations with slab thickness or slope angle. In most cases it was difficult to understand the processes that cause stability variations (Campbell, 2004; Campbell and Jamieson, 2004).

Table 1 – Commonly used scale names and their characteristic lengths (after Kronholm, 2004; Hägeli, 2004*).*

Name	Description	Characteristic Length
Grain-scale	The size of individual snow grains or crystals.	0.1 mm – 1 cm
Layer-scale	Typical snow layer thickness.	1 cm – 10 cm
Snowpack-scale	Typical snowpack thickness.	10 cm – 5 m
Study plot-scale	The size of a typical study plot.	5 m – 30 m
Slope-scale	The size of typical avalanche slopes.	5 m – 100 m
Basin-scale	The size of typical mountain basins or bowls.	100 m – 1 km
Regional-scale	One or a few mountains.	1 km – 10 km
Mountain range-scale	Several mountains.	10 km – 100+ km

Consider the rutschblock test array shown in Figure 1. Due to the condition of the surface hoar weak layer, it was hypothesized that the stability pattern observed in this array was a result of the destruction of the surface hoar by wind when it was on the snow surface (B. McMahon, 2004, pers. comm.). Terrain undulations caused some areas of the slope to be sheltered from the wind while other areas were exposed. This resulted in areas of low rutschblock scores where

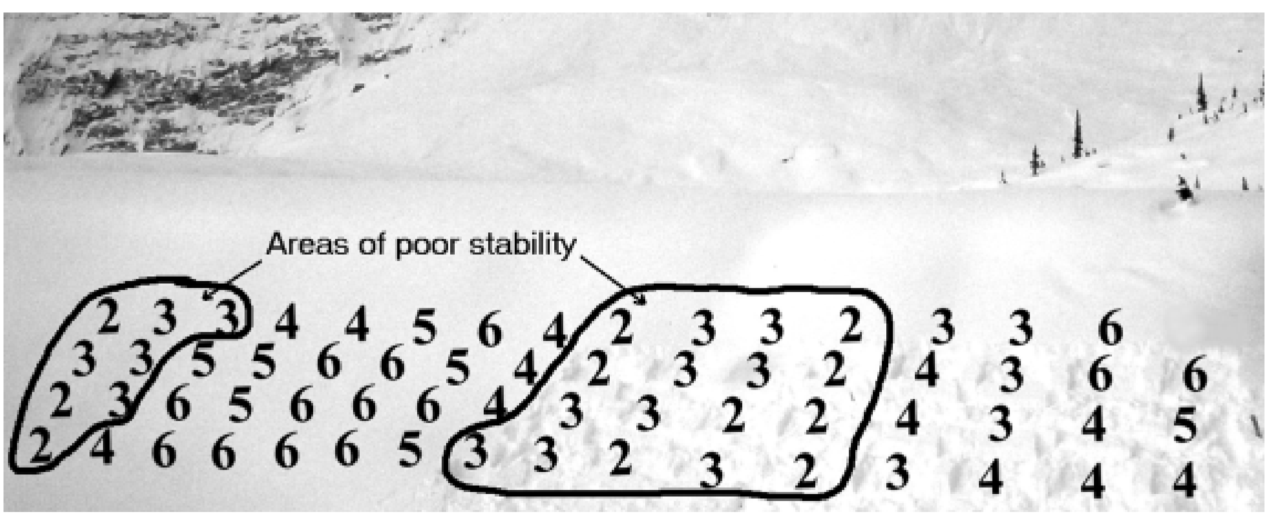

Figure 1 – Rutschblock test array performed on the headwall above the Abbott weather plot on 2003-02-27/28. All the tests failed on the 030215 surface hoar layer at an average depth of 52 cm. Areas of poor stability are circled. Average slope angle is 33°.

there were depressions in the snow surface and areas of high rutschblock scores where the snow surface was relatively high. While this explanation and understanding is reasonable for a single event in hindsight, the data requirements for modeling or mapping the observed stability distribution in real time would be enormous and operationally unfeasible.

Measurement scale

So what are the scale characteristics of an observation that adequately captures a specific phenomenon? Blöschl (1999) and Hägeli and McClung (2001) identify three scale attributes of measurements (Figure 2) dubbed the *scale triplet*. S*upport* is the area or volume integrated into a single measurement, *spacing* is the distance between measurements and *extent* is the distance spanned by a set of measurements. In the rutschblock array example presented above, the support would be the area of an individual rutschblock, the spacing is the distance between individual tests and the extent is the size of entire test site (Figure 1). In order to measure the distribution of snowpack properties accurately, extent, support and spacing have to be chosen according to the natural scale characteristics of the phenomenon (Hägeli and McClung, 2001). For example, if the extent is smaller than the characteristic length of the process then the distributions appear as trends in the data (i.e. only part of the process is captured). If the extent is much larger than the characteristic length, but the support and spacing are insufficient, then the distributions appear as noise. Figure 2 gives an example of (a) an adequate measurement scale and (b) an inappropriate scale choice.

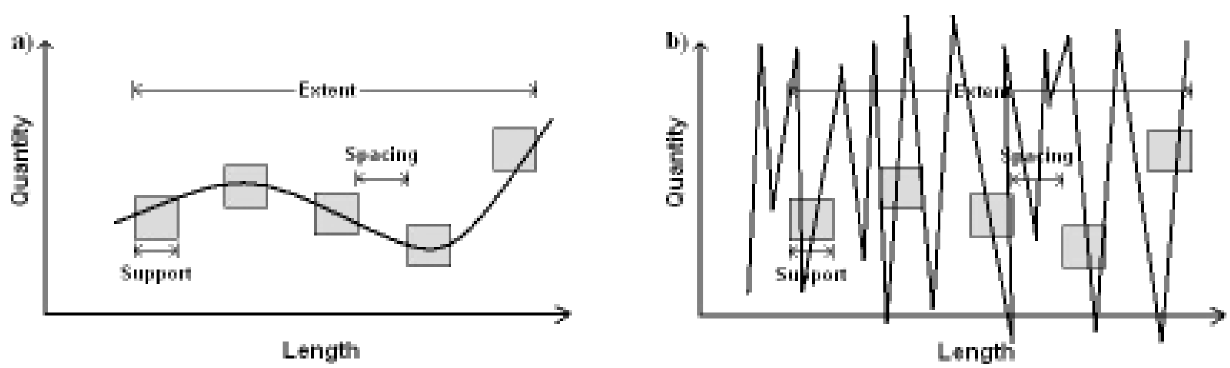

Figure 2 – Scale triplet (support, spacing and extent) for a set of measurements (after Blöschl, 1999; Hägeli and McClung, 2001). The measurement scale is adequate for the process (black line) shown in (a) but not for the process shown in (b).

Why not?

Most people would agree that to map hazard, danger or risk, stability is an important element, and accident statistics are telling us to focus on human triggering, so an index of skier stability is interesting. Well, there are at least two indices of skier stability: Sk (Jamieson and Johnston, 1998) and the threshold sum (TS) approach (Schweizer et al., 2004). Sk is similar to the standard stability index based on shear frame results (i.e. ratio of strength to stress), but the additional stress from a skier is included. The TS approach identifies structural weaknesses in the snowpack by summing up the number of predefined snowpack variables (from a manual snow profile) that are in their critical ranges. When experienced people select the site and make the manual snowpack measurements, both indices correlate with the frequency of skier triggering on the same slope, but such measurements are impractical for small scale mapping.

Let's start with Sk. One could code Sk < 1 as low stability, 1 = Sk = 1.5 as moderate stability and Sk > 1.5 as high stability (Jamieson and Johnston, 1995), or something like that. Further, Sk depends on slope angle, weak layer shear strength, slab thickness and ski penetration, which depends on slab properties, so we have a physically based equation for the effect of some key variables on skier stability (Jamieson and Johnston, 1998). A couple of interaction diagrams would show that slab thickness and weak layer strength have stronger effects on Sk than slope angle within the relevant range. While DEMs can give us slope angle over 20 m, the other parameters are generally measured at weather stations or study plot observations that are usually 10s of km apart (mountain range-scale). Based on the discussion above, this measurement scale is clearly inadequate for measuring snow stability with the goal of mapping it at a small scale. In addition, slope angles derived from DEMs contain significant errors due to the accuracy of the original terrain data and the calculation method. Without including accurate additional small-scale information with a comprehensive understanding of its effect on snow stability is it not feasible to create small-scale stability maps.

Okay, let's try Schweizer et al.'s (2004) TS approach. High values of around 5 could be coded as low stability, medium values of around 3 or 4 as moderate stability and lower values as high stability. That is the easy part, and the part that generates false hope. The TS approach requires six variables including slab thickness, difference in grain size between the weak layer and adjacent layer, difference in hardness between the weak layer and adjacent layers, and hardness of the weak layer, which we cannot estimate on the scale of 20 m from available data (weather data or snow profiles 10s of km apart). Again we have a serious scale issue between the data that is operationally available and our goal of small-scale maps.

How about stability as generated by snowpack evolution models such the French Safran-Crocus-MÉPRA (SCM) (Durand et al., 1999) or the Swiss SNOWPACK model (Lehning et al., 1999)? SCM was designed to predict snow stability (natural and skier triggered) at the mountain range scale (massifs of approx. 500 km^2) based on assimilated weather and snowpack observations at that scale. Calculations include the effects of slab and weak layer properties, as well as slope angle on "skier" stability. In this case, there is no discrepancy between the measurement and model scale. The results are of course quite general, but they have shown some correlation with avalanche activity at the mountain range-scale. However, models are usually designed to be used for a specific scale and to use them at a scale different from the intended one would be incorrect. SNOWPACK uses a different approach: based on high quality meteorological measurements, SNOWPACK models the snowpack evolution at a particular location. While the local calculations might be quite accurate, the big issue here is how to extrapolate the model results to the surrounding terrain (Fierz and Lehning, 2004).

So, why can't we just model the weather data at the slope-scale? If we have weather stations giving us winds and DEMs giving us slope-scale terrain attributes, can't we estimate wind drift patterns and hence slab thickness distribution for a slope? There have been some interesting and successful research studies (e.g. Gauer, 1998; Doorschot et al., 2001; Durand et al., 2002) but we're not quite there yet operationally because high accuracy is a big concern for practical applications (Schweizer et al., 2003). To use measured or modeled weather data as inputs for stability models with current methods requires many closely spaced wind sensors (expensive) and intensive modeling. Otherwise, the results would not be useful at the scale relevant for avalanche formation (Schweizer et al., 2003).

Small-scale mapping of noisy variables becomes more reasonable if one averages over longer time periods. The BC PRISM map of precipitation over terrain is a good example. However, winter mountain recreationists have little interest in long term averages of stability. If one produced such a map, some would interpret it as tomorrow's stability forecast, no matter what the title and disclaimer said.

Given the arguments presented in this article, it is apparent that the gap between the data required for small-scale mapping of snow stability and what is currently available and operationally feasible in the near future is substantial. Even with arrays of stability tests we often cannot explain, let alone predict, the stability patterns we find. If we are going to reliably extrapolate at this scale, we have to at least be able to explain these patterns. While avalanche professionals have developed skills to deal with the complexity of scale issues, we are far from formalizing this process and producing a reasonably accurate small-scale representation of stability over terrain.

Acknowledgements

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Correction

***Editor's Note:** In the last issue of* Avalanche News *we presented a research paper by Laura Adams entitled: "Supporting Sound Decisions: A Professional Perspective on Recreational Avalanche Accident Prevention in Canada." Regrettably, a graph was omitted on page 58. Below is a reprint of the section as it should have appeared. Our apologies to Laura and our readers.*

Results

Primary Causes of Recreational Avalanches

Respondents identified "human factors" and "choice of terrain" as the primary causes of recreational avalanche accidents followed by "inadequate snowpack assessment" and "failure to recognize meteorological effects on the snowpack." Respondents also indicated that human factors are not a separate cause in avalanche accidents but *are "inextricably linked to the ability to make choices or evaluation"*(comment from a survey respondent).

Human Factors

The second section of the study focused on human factors. Ninety-seven percent of the respondents believed that human factors have a moderate or greater influence in avalanche decision making (Figure 3). Level of experience and training / education are two other key human factor themes that were identified as having significant impact on the decision processes of recreationists and are discussed in the next section. Human factor meta-themes from qualitative responses were:

- *"The human factor is really the greatest deciding factor. This is what determines what tools recreationists have and how they applied."*
- *"Human factors and decision making processes are the main hazard, not the snow."*

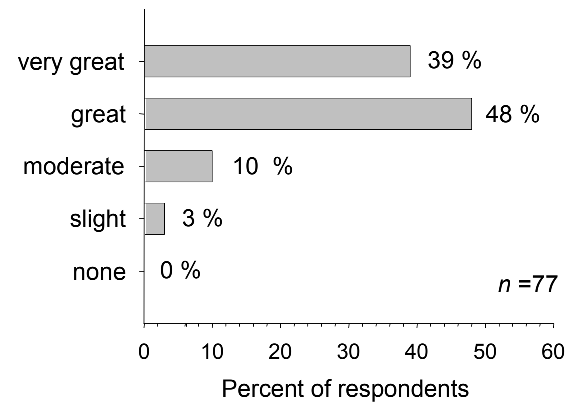


Figure 3. The extent that human factors influence recreational decisions resulting in avalanche accidents.

The CAA's Oral History Project

BY CHRISTINE EVERTS

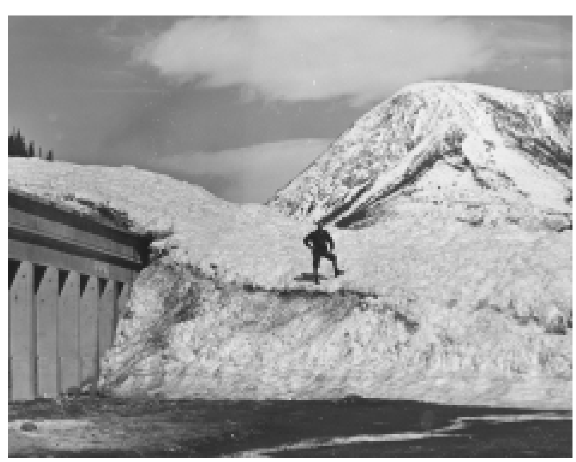
***Editor's Note:** In the spring of 2003, the CAA Board of Directors decided to use money from the Art Twomey Memorial Fund to finance the creation of an oral history of the CAA. Key avalanche pioneers were selected to share their memories and insights into the growth of the avalanche industry. A steering committee, comprised of Margie Jamieson, Simon Walker and Gord Burns, helped determine the terms of reference and the individuals to interview for the project. Christine Everts was contracted to conduct the interviews and write the history, while Susan Hairsine volunteered to provide overall project management, report collation and distribution.*

In the last issue of Avalanche News*, we looked at the evolution of public avalanche safety practices and saw how Canadian and US avalanche pioneers worked together to create many of the procedures still in use today. In this chapter, we'll learn how avalanche control and forecasting techniques have also benefited from the same cross-border collaboration. This is our final instalment of the CAA's oral history project. Enjoy.*

The Development of Avalanche Forecasting and Control Systems

"At first, I think our trust was in putting everything into a neat box, A+B=C that sort of thing. Then we realized we just don't have the tools to even begin to gather information of that precision, to put it into a formula and have a result that is meaningful…"[1]

As early as the 18th century, Europeans attempted to describe avalanches and classify them into different types. However, the true foundations of avalanche research were not developed until the second half of the 19th century. In 1872, Swiss forestry inspector Johann Coaz initiated a nation-wide avalanche survey. The survey was followed by the 1881 publication of his book *Lauinen der Schwizeralpen* (Avalanches of the Swiss Alps), the largest and most comprehensive avalanche work to date.[2] By the 1930s, the Swiss federal government in Berne had appointed an Avalanche Commission of 15 members. The Commission was composed of scientists, engineers and foresters whose task was to establish a study program for snow, avalanches and avalanche defence measures.[3] Following the Second World War, in 1948, the NRC invited Marcel de Quervain, a senior Swiss scientist from the Federal Institute for Snow and Avalanche Research, to come and make recommendations about the type of research to be carried out in Canada.[4]



That same year, Noel Gardner, the son of an Albertan rancher, became a warden in Glacier National Park. A man described as being ahead of his time, he pioneered avalanche studies in Canada, and rightfully earned his nickname, "Old Snowflake." Gardner came to the mountains in the 1940s, learning ski techniques and avalanche basics from friend and mountain guide, Bruno Engler.[5] After acquiring his warden position, Gardner began observing weather patterns and avalanche activity. As the first professional avalanche researcher in Canada, he established snow observation guidelines that are still used today.[6]

Tim Auger shared the following story. "Keith[7] told me a story of Noel Gardner. Anytime I'm swapping stories with other avalanche people who may not have heard this, I always have to truck it out. It's such a classic. Noel Gardner is up at Fidelity and its blizzarding and the middle of the night. There is someone else up there with him and they're drinking whiskey and playing cards. As Keith's story goes, Noel had this dog there. It was a little mutt with long hair that looked like a mop. So in the middle of this session Noel calls the dog over to him. The dog comes over and Noel tips his chair back, grabs the dog by the fur and picks him up. Then he leans over and pulls the door open, heaves the dog out into the blizzard and slams the door and plays his next hand of cards, just like that. A few minutes later there is a whimpering at the door. It really was howling apparently (which makes a better story). Noel tips the chair back, opens the door, and of course the dog comes scampering in. He slams the door against the blizzard, picks the dog up again by the scruff and plunks him in his lap. Then he reaches over his other shoulder to a shelf, gets his hand lens, leans over and takes a close look at the dogs back. Noel sits back and makes the pronouncement, 'Yep, dendrites!!!' (which is a star-shaped snow crystal)."[8]

Gardner, who was described as a true character by the majority of participants in this project, was a contemporary of Montgomery (Monty) Atwater. Atwater was credited with launching the development of avalanche science in the United States (U.S.).[9] In the words of Ron Perla, "You see Atwater had a reputation for being ornery, but Noel Gardner REALLY had a reputation for being ornery!"[10] In his book, *The Avalanche Hunters*, Atwater, described Gardner as follows: "Like myself at Alta, no one told Gardner to do avalanche research. He simply had the itch to know when and why and began to make observations on his own. And just as it chanced with me in Alta, he appeared at the right place and moment."[11]

> *"...Atwater had a reputation for being ornery, but Noel Gardner REALLY had a reputation for being ornery!" Ron Perla*

Perla, who knew Atwater, offered this description of the man and his work: "Atwater developed all the instrumentation, the lingo, and explosive control. He is the one who started it. In fact, the weapons themselves got the Forest Service all mad at him because he would fire round robin. Then LaChapelle came along as the first real scientist. Atwater was more of a romantic type, an idea type of guy. But Ed (LaChapelle) had scientific credentials, physics and math. So he really started making it into a science."[12]

The Canadian science of avalanche control and forecasting was something Atwater admired. "When I visited Rogers Pass in 1963, I could only envy Gardner and his data telemetering system. It was all done by radio, from several different points. This was at a time when Wilson and I were tailing bulldozers around Squaw Valley, cable splicing kits in hand."[13] Atwater noted the difference in avalanche research between Canada and the U.S. He credited the NRC, its scientific and technical resources and its authority to apply them, with the growing success of avalanche research in Canada.[14]

With the groundwork established by Gardner, the science of avalanche control and forecasting was formalized during the construction of the Trans-Canada Highway through Rogers Pass. In 1956, Swiss engineer Peter Schaerer was hired by the NRC as a snow researcher. His avalanche work initially involved "determining the preliminary locations of snow sheds, mounds and deflector dikes," as well as, "studying the feasibility of retaining barriers [in] avalanche paths...[and] establishing snow study plots with snow depth markers at Mount Abbott, and at the summit of Rogers and Balu Pass."[15] In the fall of 1957, experimental construction of benches and earth mounds began, as did the trials with artillery.[16]

According to a report by Gardner and Art Judson, "Well planned avalanche defence systems including both artillery and structural control provides maximum protection at reasonable cost."[17] This was the strategy adopted at Rogers Pass. Along with establishing avalanche control measures, in the winter of 1958/59 the need for a high-elevation mountain observatory was recognized. The following summer (1959), the Radio and Electrical Engineering Division of the NRC constructed radio equipment for transmitting wind observations from Balu Pass. The groundbreaking work that summer was significant as remote weather stations were generally not yet available. The equipment was later moved to the observatory on the south peak of Fidelity.[18] Schaerer recalled, "Noel was quite set on Fidelity Mountain right from the beginning and frequently mentioned that it would be a good place for an observatory. I was not so keen on it. It was sort of on the west side of the whole problem area, not in the centre."[19] When icing problems later developed at Fidelity, the equipment was transferred to the Round Hill above the observatory.[20]

Snow observers working for the Department of Public Works (DPW) initially manned observatories. Schaerer spent part of his first year at Rogers Pass educating them on the properties of avalanches and avalanche control. In 1959, it was decided that national parks' staff would become responsible for snow and weather observations.[21] Due to his previous work, Gardner was given the job. Fred and Walter Schleiss were hired as his assistants.[22] Together they became responsible for ensuring the safety of future highway travellers.

Hans Gmoser praised the control work of Gardner and his team. "The best example is what has been done at Rogers Pass, starting with Noel Gardner who identified the avalanche paths - the trigger zones - and set up the program with the armed forces to shoot

"Under Freddy Schleiss, I think it was developed to perfection or as close as it can come to perfection." Hans Gmoser

them down with artillery. Under Freddy Schleiss, I think it was developed to perfection or as close as it can come to perfection. I was always very impressed by what he did. On a number of occasions, I was actually able to go with him and he would direct the shot to be fired at such and such a place. He'd say, "This one is going to come down to that bench." He had so much data in a relatively controlled environment…that is really a great example of what can be done."[23]

While the national park team established a system of avalanche forecasting, Schaerer spent the following year finalizing the location of the earth works and writing reports that summarized his observations and recommendations for control at Rogers Pass. After presenting his final paper at the annual meeting of the Engineering Institute of Canada, Schaerer returned to Switzerland.[24] After three years in Switzerland working on highway development, he returned to Canada and resumed his position with the NRC. "I studied snow removal problems on roads, for example. I developed guidelines on the amount of salt needed for the control of snow and ice. Then my superiors recognized that there would be a future demand for avalanche information and suggested that I should go back to do avalanche studies."[25]

As avalanche studies developed at Rogers Pass, so did control and forecasting techniques. Willi Pfisterer worked as a snow observer at Rogers Pass and lived up at Fidelity with his family. "I grew up in an avalanche area [in Austria]. We had all kinds of troubles and accidents. Being out in the field I had a real gut feeling for the whole thing, as a guide you know. I am still sitting here after 50 years of it. But, scientifically, I knew nothing. So at Rogers Pass, I was there for three years and I learned all that. You cannot phone down to the forecaster and say, "I [have] a bad feeling – you should close the road." You have to come with some facts and that I learned at Rogers Pass. I did basically all the outside work. I'd go to the remote stations and all that stuff, which was a real bonus for me, you know, to learn this because afterwards I really needed it. Then we went to Switzerland for some courses and some rescue work. Then we went to the States to Alta, Utah, where the Americans had their main thing. We went to all the ski areas and looked at what everybody was doing with their control systems."[26]

Despite his guiding and rescue experience, and his desire to learn the science behind avalanche control and forecasting, Pfisterer was initially overlooked for the snow observer position. "Some funny things happened bidding on that job. I think I was called an observer. There was one guy and he had partaken in one of the schools I had run. Then he got a certificate for being in that school, which was signed by me. Then he won the competition over me because he had the certificate and I didn't! That's government, you know! But afterwards they corrected it. That was pretty funny. He was my assistant at Rogers Pass. But that's how they go. You have to have the certificate…."[27] Similarly, Bruno Engler, Noel Gardner's mentor, later worked as one of the original members of the avalanche survey crew at Rogers Pass under the direction of his former student and Peter Schaerer.[28]

"I spent half my career indoctrinating the wardens and the Canadians to have some confidence in themselves, you know, because we were just as good as anybody." Willi Pfisterer

Observing control and forecasting systems in avalanche areas in Europe and the U.S. gave those involved in the Canadian avalanche industry access to the most up to date techniques in the world. It also gave Canada the opportunity to become a leader in the avalanche business. Pfisterer noted, "Rogers Pass avalanche control really had their act together. This was the biggest avalanche control centre in the world. We went to Switzerland and to America to the ski hills to look at what everybody was doing. We took the best of them all and applied it at Rogers Pass."[29] He went on to comment on the success of the Canadian avalanche industry. "This is typical Canadian you know. They got something really good and they ignore it. They always look at the Americans thinking that they do everything better. I spent half my career indoctrinating the wardens and the Canadians to have some confidence in themselves, you know, because we were just as good as anybody."[30]

In addition to establishing systems to deflect or decelerate avalanches in motion, experiments with explosives to release avalanches under controlled conditions began.[31] As early as 1881, miners in Alta, Utah, noted that the explosion of a heavy charge of gunpowder, hundreds of feet beneath the earth's surface could start the snow moving overhead.[32] Explosives soon became a primary tool in avalanche control. Under the administration of the Canadian Armed Forces, the 105-millimetre (mm) Howitzer was used as an integral and proactive avalanche control strategy in Rogers Pass.[33]

Outside Rogers Pass, recoilless rifles were used. Former Jasper park warden Toni Klettl recalled, "First we heard they were using the recoilless rifle at the Granduc Mines near Prince Rupert, so over in Jasper we thought if they were capable of doing it…we should be capable of doing it, too. But with government bureaucracy, the army didn't want to cooperate. After that, we finally got permission to buy it, but we couldn't buy it in Canada. There were recoilless on surplus too. We had to bring it up from the States. The same with the shells. They came from army surplus too. We had one at Marmot and one on the south highway. At Marmot, actually, we didn't need the 105; the 75 would have been fine because the range wasn't there. But the 75 wasn't available anymore."[34]

In the 1960s, avalanche personnel began to experiment with other forms of explosive control. According to Klettl, "In the ski area up in Marmot we were the first ones to use the Avalauncher. I forget now what year it was. Andy Anderson came up with it. An Avalauncher came up from the States to Rogers Pass… It was a pretty rough affair but there were possibilities there. We developed a pretty good system to go with it…."[35]

Pfisterer agreed. "One of the things we were involved with was the Avalauncher. I knew those guys. The guy who built the thing was sort of a genius. He was building the things, but he could not sell them. Monty Atwater (U.S. Forest Service) was the one I knew quite well from the avalanche courses we took from them. We (Jasper National Park) had an Avalauncher, they were very primitive at the time. Monty phoned up and said, 'There was an accident in the States and they are not going to buy any Avalaunchers anymore. They are going to take them off the market.' So I bought four. I had problems with some of the wardens; they wouldn't go near it. But they established stringent safety regulations…[and] it kept them guys (Atwater, etc.) going. It didn't take very long before they came up with a better product."[36]

Perla explained the initial problems with the Avalauncher. "That was very controversial at first because it was not well developed. The releases were not being developed. People were killed with the old prototypes." He went on to say," It didn't have a military standard safety device. I think there were three different instances where there were fatalities. Because of that we did not put the Avalauncher in the first *Avalanche Handbook*. There was a quite a discussion about it. Atwater wasn't very impressed or happy, but Norm, I think, was a little more understanding."[37]

> *"I could often get away for a couple hours to help (Monty Atwater) go do some experimental shooting or just scratch our heads and talk about the thing."*
> Norm Wilson

Atwater, with the help of Norm Wilson, developed the Avalauncher in 1960 as an alternative to the recoilless rifles, which the American army warned, were becoming obsolete.[38] According to Wilson, "I helped him modify and improve it (the Avalauncher), during the time that he developed the fin stabilized projectile as opposed to the thing we referred to as the soup can projectile. The first projectile was not fin stabilized. It was the shape of a two-pound block of pentolite… We would carefully attach a cap and fuse with an igniter on it that would be ignited when we fired the weapon as the projectile left the barrel. In any case then it would just tumble through the air. It was a short-range projectile of maybe 400 metres at most. It was pretty basic…." Wilson helped Atwater whenever he could. "By this time I was the mountain manager at Alpine Meadows. I could often get away for a couple hours to help him go do some experimental shooting or just scratch our heads and talk about the thing. He basically did the work and I did a lot of critiquing. I also did some demonstration firing for him for possible purchasers of the Avalauncher."[39] Today, almost every ski hill is said to employ at least one Avalauncher, a relatively light and inexpensive tool that can be pre-set and is therefore useful in all types of weather.[40]

Another effective avalanche control tool, although limited by the weather, is the helicopter. While helicopters were used to survey avalanche starting zones in Roger Pass in 1957, their potential for avalanche control was not recognized until the Granduc Mine disaster in 1965.[41] Herb Bleuer, who worked on avalanche control at Granduc recalled, "We were the first ones to do helicopter bombing."[42] Perla referred to the early helicopter bombing in Canada, a control tool that was not yet used in the U.S. "We didn't use helicopters. We used artillery. In fact, I didn't really know much about helicopter blasting until I came to Canada and saw the wardens and how they did it…."[43] In 1969, Perla attended his first avalanche meeting in Canada, when the NRC sponsored an Ice Engineering and Avalanche Conference at the University of Calgary. Experts attended the event and it marked one of the first scientific conferences in North America dedicated to avalanches. It was during that conference that Perla remembers Peter Fuhrman, a national parks alpine specialist, discussing helicopter bombing.[44]

Not all national parks, however, used helicopter bombing. "We separated a little bit there, Banff and Jasper. Banff was quite involved in helicopter operations and we were more involved with the hands-on control, except on the Banff-Jasper Highway…."[45] Klettl related his trials with helicopter bombing. "Some funny things did happen with helicopter bombing… Oh ya, on one trip, I had a brand new down jacket on and there was a hundred pound or whatever it was explosive right beside me. My goddamn jacket caught on fire when I ignited it! I guess one of the sparks hit. Actually I had a whole bunch of little burns, but one got a little further than that. The pilot said, 'I smell fire in here.' I looked down and there was a little burn in my jacket. So I figured that was not my cup of tea, the helicopter bombing! Once in a while those igniters sparked. Actually that was one of the reasons in Jasper that we were pushing for a 105 recoilless."[46]

Along with igniters sparking, Pfisterer spoke of helicopter's dependence on the weather. "Bombing and so, that's okay if you can fly. If you want to deliver a charge on the avalanche slope, the cheapest and the fastest possible way is to shove a charge into the end of the pipe and blow it out the front. It's there in a couple of seconds. Dark or light, fog or whatever you have these designated targets and you shoot at night like they do at Rogers Pass. But with the helicopter you can't do this."[47]

While Jasper National Park relied more on the Avalauncher and recoilless rifle for their avalanche control, helicopter bombing was a method frequently employed in Banff. Helicopters played an important role in avalanche control during the "Season of the

Hundred-Year Avalanches." Early in the 1971 winter season, helicopters were used to trigger some of the biggest avalanches ever recorded in the Canadian Rockies.[48]

While one of the helicopter bombs released an avalanche that stranded 93 skiers at Sunshine Village for two days, other forms of control were used to keep the ski area and the road leading up to it safe.[49] In the words of Jim Sime, "I'll tell you what I remember of the Sunshine Road. The Sunshine Road was the main area of concern at the time. Sunshine has a peculiarity in that you can't see the trigger zones from the road. Not even when you go across the valley… This presented a special problem. How to detonate explosives in those trigger zones above the Sunshine Road? If you brought in Howitzers you would have to shoot them at the moon pretty well. A system was designed of pre-set avalanche charges. Those were set into the trigger zones out in the avalanche slopes before the snow came in the fall. These things were set in at levels. The idea was there would be pre-set charges that would be detonated by radio control when it was deemed the hazard was extreme...."[50]

Perla, a research scientist with the Glaciology division of Environment Canada, had a snow research lab at Sunshine. He collaborated with the wardens on a number of research projects and remembered, "Your dad (Keith Everts) was a real pioneer there…on the Sunshine Road… Again he worked with the people at the National Research Council and the Defense Research Establishment at Suffield. He came up with some of these devices, which are still used in various forms all over the world now. He developed an explosive system."[51] The system was the result of a joint project between the Parks Service and the Defense Research Establishment to develop a method for remotely detonating explosives.[52] The system became known as ACES (Avalanche Control Electronic System). It was retired from Sunshine in the 2002 season.[53]

In addition to collaborating on various research projects, such as the information analysis of explosive control, Perla worked with Keith Everts on the Banff Avalanche Workshop. The workshop was held in 1976 and avalanche personnel from all over the world attended it. Perla described the meeting as a forerunner of today's International Snow and Science Workshop.[54]

Simultaneous to Sunshine, an avalanche control program was developed at Lake Louise under the leadership of the Canadian Avalanche Centre's Executive Director, Clair Israelson. Auger recalled, "Clair had started up in the avalanche program at Lake Louise around, I am just guessing, 1972/73, something like that. Lake Louise is the largest of the three ski areas in Banff Park and has the biggest avalanche program. There were five or six wardens in the Lake Louise avalanche program."[55]

Perla explained, "They had a more serious avalanche problem at the Lake Louise ski hill, but they didn't have the road problem and that is where the research came in. Sunshine wasn't that impressive an avalanche area in the ski area…but the road was a problem. In Lake Louise, the ski area was the problem."[56] Due to different avalanche hazards distinct control programs developed in each area. Schaerer summarized the evolution of avalanche control methods in Canada, while also explaining why helicopters are not used for bombing in Rogers Pass. "It is the way it has always been, with applying a lot of explosives. The explosive control has been used in Switzerland since the 1930s, with all kinds of guns and hand charges. Shooting them down is essentially the best way to control avalanches. Other avalanche control and engineering works, for example snow sheds on highways, cost too much. Now, application of explosives is much more by helicopters, whereas it used to be hand charges in ski areas and shooting with all kinds of guns. The weather is against using helicopters in Rogers Pass. They cannot fly when they should. Experience in Rogers Pass shows that the snow settles and stabilizes very rapidly after a storm. Sort of a rule of thumb is, as soon as it stops snowing, the avalanches stop running and explosives have limited effect. It is not the same in other areas. The snow in Rogers Pass has some peculiarities...."[57] He went on to say, "studies in Switzerland, after the big avalanche winter 1999, led to the conclusion that the most economical safety measures would be through evacuation, closing roads, evacuating people from towns. Simply let avalanches run and keep at a safe distance."[58]

While avalanche control methods in Canada continue to rely on explosives, participants in the project suggest that forecasting techniques have changed significantly. According to Perla, "You talk about advances. I mean your dad (Keith Everts) was involved in some of these great advances. First of all I said the computer was something we had no concept of, even when I came here in 1974. Even though I had used computers as an electrical engineer, I still didn't quite understand the power of them. Your dad was the one who knew. He pioneered using the computer – the desktop computer – when it first came out. In the 1970s, he worked with a group in Winnipeg that had a way to computerize, to put on the desktop the instrumentation for Sunshine. Even Rogers Pass didn't have a computer system at this time. Sunshine was the first place to get a desktop computer system thanks to your dad working with the people in Winnipeg… This was in the days before the Apple computer and before the PC… So you ask how things have changed, we didn't have anything like this at Alta before. They were developed here in Canada."[59]

Geoff Freer also spoke of advancements in avalanche forecasting. "I think there are far more people today paying attention to the snow pack part of stability analysis compared to the old days. I think in the old days there was a lot more of just using the weather and doing explosive control or adjusting your activities due to the weather. It was a struggle…to get people to do snow profiles. Whereas today my sense is that more and more people use snow profiles in a much more meaningful way. I think that we are much more organized in our approach to snow stability analysis and hazard forecasting. I think we [now] have better processes, checklists and a more holistic approach…."[60]

Schaerer agrees. “They are much more knowledgeable about the properties of snow, the formation of avalanches, and the observations that need to be done. The staff now has a much better grasp of putting all the information together and evaluating snow stability and forecasting avalanche hazards. Whereas I had to struggle to do these things. We developed it and now there is a system. I am amazed at how these guys can describe the conditions in such short words.”[61]

“I am amazed at how these guys can describe the conditions in such short words.” Peter Schaerer

The development of a system and standards to measure snow stability can be attributed, in part, to the creation of the CAA. Schaerer explained, “After the big avalanche winter of 1978-1979, the avalanche technicians got together and each one reported on the experiences of the winter. It stimulated cooperation and the exchange of ideas. During the discussions, it evolved that we needed standards of snow and weather observations, though they existed already at Rogers Pass in Glacier National Park. The other national parks took that system over, too, and other industries came and said, “We should also adopt it and make it the rule for everybody.” In conclusion, part of the objective of forming the CAA was standards. Other objectives were better cooperation and exchange of ideas, and forming a unified voice when talking to government.”[62]

The establishment of standards, and the collaboration of ideas and information have made Canada a leader in avalanche control and forecasting. Despite much advancement, Bleuer warns, “It still comes down to the man at the desk or behind the computer who has to make the right decision, who has to come up with the right forecast.”[63]

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Christine Everts, author of the CAA's Oral History Project, was born in Banff and grew up in the mountains. She graduated from Simon Fraser University with a Bachelor of Arts in History and Anthropology and recently completed a Bachelor of Education at the University of Ottawa. Last fall she began teaching a Grade 2/3 class at the Chief Jacob Bearspaw Memorial School in Eden Valley, AB. She valued the opportunity to learn from friends, mentors and co-workers about an industry loved by her dad, Keith Everts (1942-1999), former National research Council of Canada employee and Banff Park warden.

The Canadian Avalanche Association thanks the Royal Bank Foundation for its generous contribution of $10,000 to support public education in avalanche safety programs. This contribution will go toward Snowsmart Programs, which targets avalanche safety education for teenagers in Canada.

RBC Foundation™

Editor's Note: *While November typically heralds the beginning of winter in the mountains, this year it marks the end of an era. After more than three decades with Parks Canada, Dave Skjonsberg has decided to explore some new trails, and we thought we'd give him the last word. From all of us at the CAA, good luck Dave and keep in touch!*

REVELSTOKE, 16 November 2004

This week will effectively mark the end of my career with Parks Canada. I will be taking some accumulated leave over the next few months and retire early next year. I guess this will definitively put an end to the "worst kept secret in Rogers Pass."

As many of you know this has not been an easy decision. I had no idea when I started work for Parks (as a fire lookout man in 1968 for you historians) that some 36 years later I would still be with the same organization or that I would have spent 33 years in one park. I have seen my share of change over this period - lost count of the number of job re-classifications, re-organizations and program reviews (boy, will I miss all that fun).

One thing has not changed - I still enjoy the job. It has always been more than just a paycheque, has provided intellectual challenge and has been full of rewarding accomplishments (at least in my mind). And you can't overlook the adrenalin rush you get from sitting in the middle of an avalanche path watching an amazing force of nature hurtling towards you! There hasn't been a winter morning that I haven't woken up and been eager to get to work (okay,there might have been a few summer mornings during golf season). In this regard I know that I have been especially fortunate.

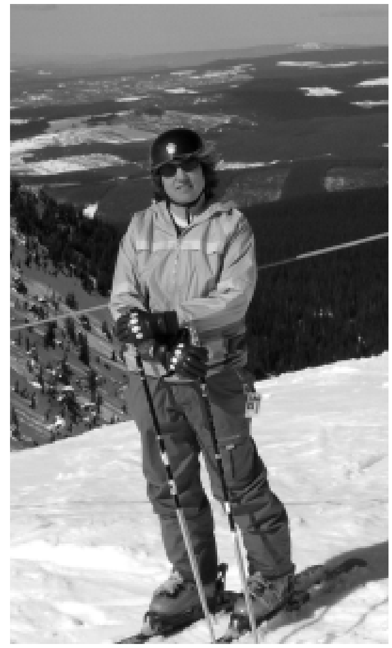
The people a person works with are so important to anyone's level of job satisfaction and here again I have also been fortunate. I have worked with many special people over the years (and even a few "unforgettable characters"). Trying to list them all is impossible - I would simply wish to say thank-you to all, past and present, who have made this such a special job and a great place to work. The Avalanche Control Section (yes, I still have to think twice here - it will probably always be SRAWS to me) presently has the most talented and qualified group of employees that we have ever had. I am completely confident that the program will continue to maintain our high standards in all areas and realize even greater successes into the future. Bruce, Jeff, Jon, Eric, Tom, Dean, Jim and Mark - my best wishes for a good winter coming up and many more to come. My hope is that all of you will be lucky enough to feel as I have - that you have one of the best jobs in the world and are privileged to work in a truly special place.

Okay, enough of the sentimentality - it's time to make some fresh tracks on some new mountains.

Take care………..

Dave Skjonsberg
Manager of Avalanche Control (soon retired)
Mount Revelstoke and Glacier National Park

Janis Borden: New Accountant

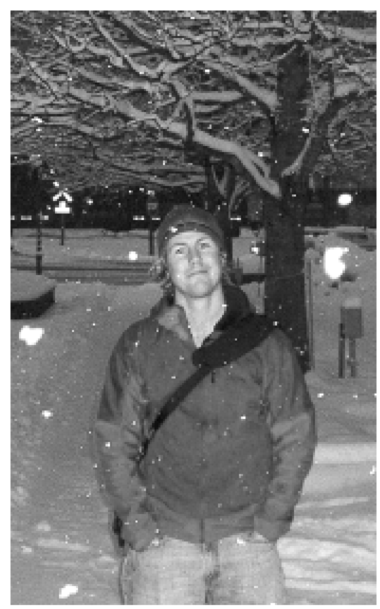


The CAA is happy to welcome Janis Borden on board as our new accountant. New to Revelstoke, Janis relocated from Kelowna in September with her two children who, she says, thank her every day for making the move. “The kids have never experienced the kind of freedom they have here,” she explains. “We live close to their school and their social and sporting calendars are maxed. They skied here last winter and are registered for racing with the Revelstoke Ski Club this year and they can’t wait!”

Janis has both business office and secretarial training and has completed two years of the four-year Chartered General Accountant program. She has worked for Shoppers Drug Mart for the past 14 years in both Vancouver and Kelowna, but a new relationship brought her to the area. “I fell in love with Revelstoke (and my boyfriend) and decided to make the move,” she says. “I have to admit it was a bit scary leaving a 14-year position and moving here without employment. But I knew I didn’t want to be a lifer at Shoppers Drug Mart, so I took a chance.”

She’s had big shoes to fill with Pat Cota leaving, but Janis is up for the challenge. “I love my work at the Centre,” she says. “I thrive on change and learning new things.” There is no shortage of new things to learn; her arrival coincided with the public launch of the CAC, which will have a huge impact on our accounting practices. As well, we will be implementing a new accounting software program in the new year to manage the CAA’s expanding resources. “I can see already that there is so much going on and lots of ongoing change. I will never be bored here!”

Greg Johnson: Public Avalanche Forecaster



Age: 30

Lives in: Revelstoke

Employer: Canadian Avalanche Centre

CAA member since: 1999

Years involved in avalanche safety: 7

Preferred method of snow travel: Splitboard

Number of days on snow per year: 100+, until this season when I took an office job!

Short history of previous experience:
Another alumnus of the University of Calgary’s Applied Snow and Avalanche Research Program, Greg completed his MSc in Civil Engineering, Avalanche Mechanics in 2000. He spent four years working as a public avalanche forecaster with the US Forest Service in Utah and Idaho. In the summers he works as a climbing ranger for the US National Park Service at Mt. Rainier.

What motivates you as a Public Avalanche Forecaster:
I find it very gratifying when people tell me that our forecasts helped them make good decisions in the mountains.

Expectations, plans/vision for the future:
I hope to learn from my experience at the CAC and at the same time help build the public forecast program.

Off season pastimes:
Skateboarding, climbing.

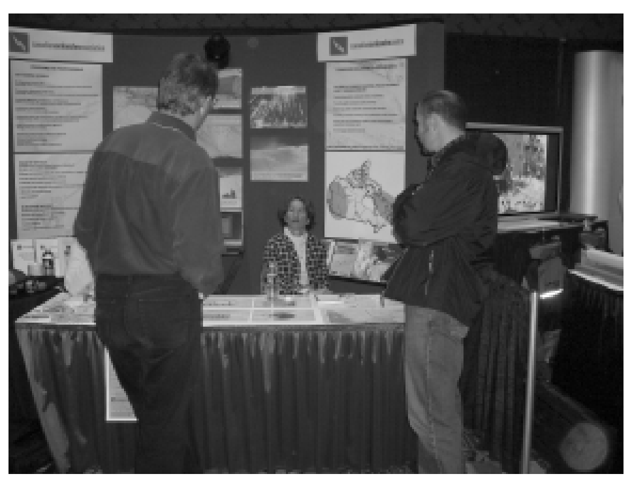
MEC Vancouver Promotes CAA

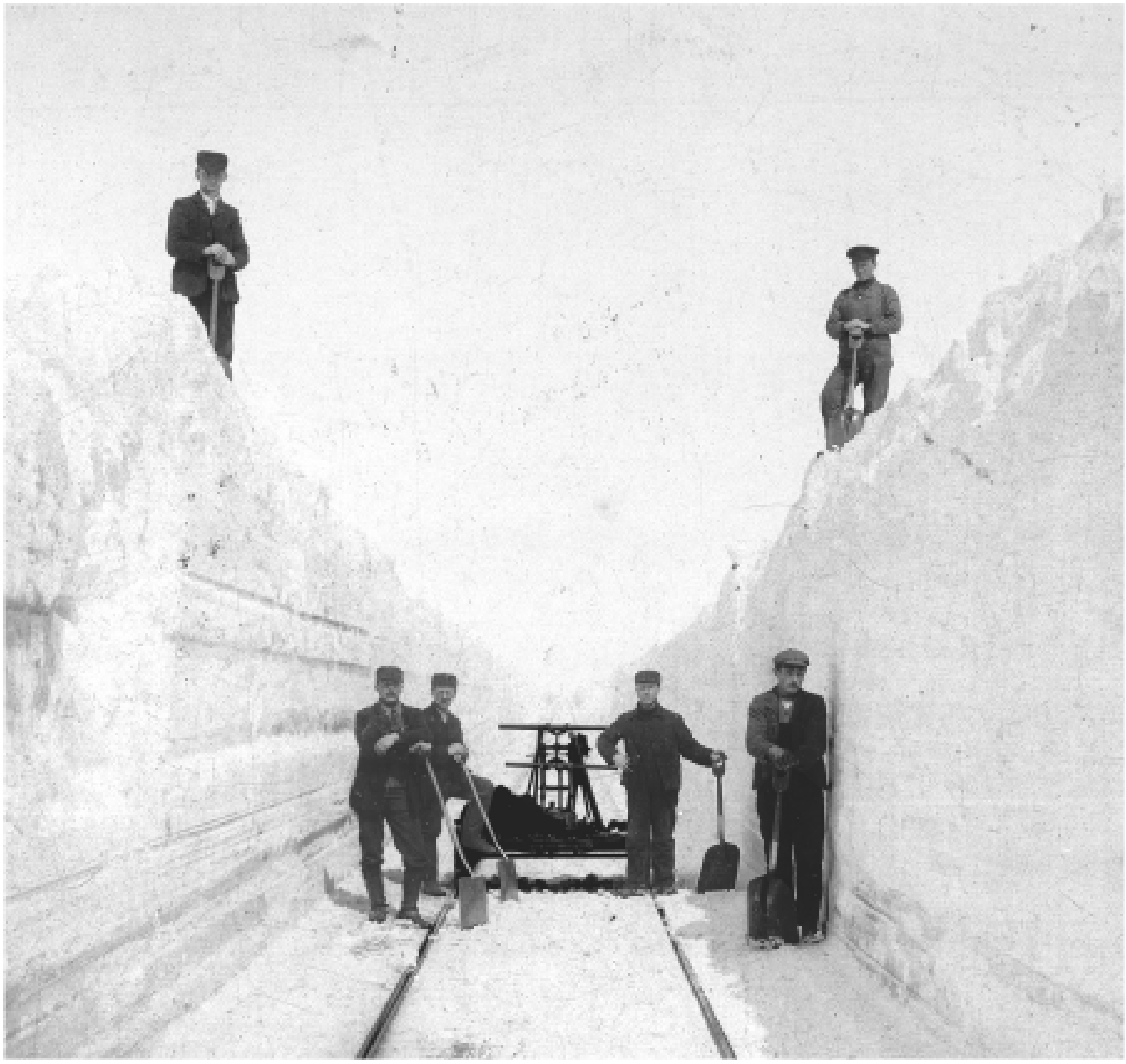
MEC Vancouver has devoted one of its West Broadway storefront windows to promoting avalanche safety and the CAA. The 20-foot long display has been up since mid-October and will remain in place until mid-January. MEC Community Involvement Coordinator Laurie Edwards says the window's theme "ties in well with our promotion of free rental of snow safety packages for RAC participants." The display has attracted a lot of positive attention and is another great example of partnership in action. Thanks, MEC!

SARScene 2004

Staff and volunteers from the Canadian Avalanche Centre were on the road again, stopping in Calgary in October to attend SAR*Scene*, the National Search and Rescue Secretariat's annual workshop for search and rescue (SAR) professionals. More than 600 delegates from Canada, the US and beyond attended the four-day event and took in pre-workshop training courses, the SAR Games, demonstrations, a trade show and more than 70 presentations, including one by Clair Israelson. He spoke to an interested audience about the challenges and opportunities associated with managing avalanche risk in Canada.

Once again the event proved a great opportunity to showcase some of the world- class avalanche accident prevention materials and programs developed, in part, with funds provided through the Secretariat's New SAR Initiatives Fund. This year, Alan Jones, Mary Clayton, Rupert Wedgwood and Susan Hairsine "personed" the CAA booth and spread the word about CAATS courses, industry and member services, and public avalanche safety programs.





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