

# Avalanche

## REVIEW

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Heli Blasting at Crystal Mountain, April 3, 2011. With the previous mission producing an R5D4 result within the Crystal ski area, patrollers Paul Harrington and Christina Von Mertens find out how many explosives can fit in the back of a Hughes 500. *Photo by Chris Morin*

see Crystal story  
on page 21



## CRUST THOUGHTS

A rain event on Martin Luther King Jr weekend, 2011, produced a widespread and variable crust that caused avalanche events of different sizes, triggers, and time sequences. See page 20 for the rest of the crust stories.

Story by Karl Birkeland

Much of this issue of TAR is focused on crusts and how they affect avalanche conditions. In particular, Lynne asked readers for feedback on the so-called “MLK crust” formed in mid-January of 2011. I cannot comment directly on that crust event as it was not a big player in the Montana snowpack, and knee surgery around Christmas limited my field time. Despite my lack of knowledge of the MLK crust, Lynne still asked me to comment generally on crusts for this issue, so here are some fairly random musings on buried ice crusts.

When an ice crust is buried, seasoned avalanche practitioners keep careful track of it. We’ve been trained to recognize that

even subtle changes in structure in the snowpack need to be monitored, and ice crusts clearly form dramatic discontinuities. Even if the snow surrounding the crust is well bonded initially, the changes in porosity and conductivity associated with a buried crust might well lead to snowpack weaknesses resulting in dangerous avalanche conditions. Sometimes when an ice crust becomes buried, the crust and the crystals around it become a season-long problem over a large area (*many examples exist, such as Jamieson and Johnson, 1997*). However, other times a crust will form and be buried, and there will be no weakness whatsoever associated with it. Why the difference?

See story continued on page 20 ➡

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*Even with crusts, what I call Ron Perla’s First Law of Avalanche Forecasting – the only rule of thumb is that there are no rules of thumb – still applies!*

—Karl Birkeland, *Crust Thoughts*, pg 20



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## from the executive director

### HURRY: There's Still Time to Update your Contact Info

This past summer and fall we've sent out renewal reminders and meeting notices via Constant Contact, an online email marketing provider. We've included announcements regarding this transition to electronic communications in the first two issues of TAR this year. Your response has been great; it seems to have caught on. Thank you. This improves our administrative efficiency, which means keeping our operating costs low.

But, we haven't caught up with everyone, so we've extended the grace period to two issues of TAR so that you won't miss an issue while we transition to this new program. If you usually renew in the fall and you haven't renewed, this will be your last issue.

Unsure about your status or your renew date? It's easy to find out: go to [avalanche.org](http://avalanche.org) and click on the "professionals" dropdown menu, then select "AAA Membership Directory." Remember, we need a current usable email address for you for renewal notifications and meeting announcements. AAA does not share or sell your contact information. Send us your email and mailing address updates anytime during the year to [aaa@avalanche.org](mailto:aaa@avalanche.org).

In the future as we continue transitioning to more complete online membership management, you will manage all your contact information online. When this transition will occur remains undecided – we want to make sure we get it right, but it will be soon and again, may take a little getting used to. Thanks in advance for helping make this new program a success.

We have new American Avalanche Association decals. Since we don't do much direct mailing anymore, just shoot me an email at [aaa@avalanche.org](mailto:aaa@avalanche.org) with your mailing address, and I'll send you some while supplies last.

Winter is upon us. It's been a slow start in some locations, but it's been in full swing in the east San Juans of Colorado since early October. My first day on skis was October 7, and conditions were very good. I hope by the time you read this in early February you are enjoying some fine conditions as well.

I wish you all a safe and successful winter.

—Mark Mueller, AAA executive director ❄️



AAA Executive Director Mark Mueller and the necessities of life: a cozy yurt, fat backcountry skis, more than just one PBR, and *The Avalanche Review*. Mark and his wife Sandy Kobrock are the proprietors of Wolf Creek Backcountry and the Pass Creek yurt outside Pagosa Springs, CO.

## from the editor



The editor's birthday, on Olive Oil, in Grand Teton National Park. Photo by Dan Powers

### Wrestling with Powder Demons

I have been teaching avalanche classes for a couple of months now this winter, working with people, watching them get it, helping them use their new vocabulary in sentences and make appropriate decisions, albeit guided decisions in an institutional setting.

Right now, however, I am the skier that I warn students about in our Human Factor/Backcountry Psychology classes. Just like most of you, we had a snow drought in the Tetons for much of November and

December. Hardly anything was filled in enough to ski, and the bowls underlain by weeds and grass were mogulled like a ski area. We exercised patience and skate skied for fitness.

Then at New Years it began to snow hard; stability plummeted; we skied but we were afraid, stuck to low-angle slopes and the ski areas. Another recent storm brought 3+ inches of SWE to our mountains, closed Teton Pass for three days, and gave us ubiquitous red on the avalanche forecast. We dialed it back once again. Cold temps then gave us another 11+5+ whatever comes tonight, and I want to ski. I want to get into those steep filled-in trees and feel the pull of gravity and soft welcome of powder. I say to myself and my ski partners, "The drought surface is now 1.5 meters down, no whumphing or cracking today, let's go have a look." I have high desire and still some uncertainty. Life feels short, powder days at a premium. Where do I find the patience to draw back, to simply go poke around and gather information before making that appropriate decision?

Perhaps some insight into patience will come with this issue of TAR, reading Drew Hardesty's take on events in Little Cottonwood on November 13, 2011, when powder fever prevailed over assessment of consequence. I think of one element of my Backcountry Psychology presentation, the "pre-mortem test," where, in your mind's eye, you see yourself in the headlines of the next day's paper, or, as Mark Staples of the Gallatin puts it, your boss calls you in and says, "Now let me get this straight..."

I'll wrestle with the powder demons tomorrow, but tonight I want to introduce you to this issue of TAR, where we present you with many views of a widespread rain crust, both theory and particular case studies. My take-home lesson about crusts is actually that they are more complex than I ever considered. Cora Shea's sensitive imager and insights helped me see that, literally, while Chris Morin's meticulous analysis showed me the importance of a long-term understanding of the inter-relatedness of ALL the weather factors, and how a colorful spreadsheet really helps. Special thanks to Karl Birkeland, who amiably agreed to write on crust theory for TAR at the last minute; although he got an extra day beyond deadline to ski with his daughters on his birthday.

Finally, I want to thank many of the mentors of our avalanche world, whose insight continues to grace TAR. Ron Perla's story of the history of the Alta Schools and the National Avalanche School shows me that, as Ed LaChapelle told us in *The Ascending Spiral*, we are continually building on the ideas of those who came before. I sure would like to use some of Ron, Ed, and Monty's case studies in my own classes. Rod Newcomb reminds us of the Ram Penetrometer's usefulness in detecting vast differences in hardness, e.g., the MLK crust and its burden last spring; and Sam Colbeck gives us a nugget of understanding about temperature and crusts. Readers and mentors: share your thoughts and questions with TAR please.

For the final issue of the 30th year of *The Avalanche Review*, I plan to show you some photos, tell some stories of the slides that ran on the drought layer – do send material on as soon as possible for this topic please. I am also gathering opinions and ideas from guides, educators, anyone who is responsible for others in avalanche terrain; how do you dial your risk tolerance personally and programmatically?

—Lynne Wolfe ❄️

Crusts sometimes  
cause dramatic  
and persistent  
weaknesses that  
lead to difficult-  
to-forecast  
avalanches for  
an entire season.



Crown from Three Way Peak avalanche at Crystal Mountain Resort (see story on next page). Photo by Chris Morin

## CRUST THOUGHTS

*continued from cover*

### What Makes a Crust Problematic?

In my opinion it is not about the crust itself, but rather what is around the crust. Is the crust bonded to the adjacent layers, or are there facets around the crust leading to poor bonding? The conditions under which the crust forms, and the subsequent temperature conditions through and around the crust, are critically important.

If a wet layer is subsequently buried by a thin layer of new snow, facets may form quickly around that crust through a process called melt-layer or wet-layer recrystallization (Birkeland, 1998). This buried facet/crust combination can be problematic for weeks or even months.

Crusts that exist at or near the surface during cold, clear weather can have large temperature gradients across them as the snow around them facets due to diurnal recrystallization (Birkeland, 1998). While the other snow is faceting, even more dramatic faceting may occur immediately adjacent to the crust. Subsequently buried, this will again form a persistent and dangerous weakness.

We do not yet fully understand how crusts affect the temperature gradients across them. Cora Shea's groundbreaking work at the University of Calgary shows the complexity of the problem using infrared images of snowpit walls (Shea et al., 2011; 2012; Shea and Jamieson, 2011). Cora's work shows

some unexpectedly large temperature gradients around even deeply buried crusts. (see story on page 28)

Further, sometimes a crust can be warmer than the snow around it and sometimes it can be cooler for reasons we do not yet fully understand. The bottom line is that there is a lot going on at and around crusts in terms of temperature gradients, and much more work needs to be done before we will have a complete understanding of the gradients and the different processes driving those gradients.

Of course, the reason we are so interested in the temperature patterns and gradients is the subsequent metamorphism of the crusts and adjacent snow. Ethan Greene did extensive laboratory work on snow samples with crusts, and he showed how a temperature gradient across a sample results in more dramatic faceting around a crust than in the nearby snow (Greene, 2007). Interestingly, the most pronounced faceting occurred within a crystal or two of the crust. While these effects dramatically (and adversely) affect bonding to the crust, they cannot be easily detectable with our relatively crude field techniques. Similarly, the gradients being investigated with infrared images cannot be measured with the basic stem thermometers we all use.

### What Should Be Done?

So, what should we do about crusts? On the one hand, we know that sometime they do not cause

avalanche problems. It seems that this is more likely to be the case when they are buried quickly and deeply and where they are largely unaffected by temperature gradients. On the other hand, sometimes they cause dramatic and persistent weaknesses that lead to difficult-to-forecast avalanches for an entire season.

These latter cases typically occur when the crust and the surrounding snow is subjected to temperature gradients, though sometimes these temperature gradients can occur over short time scales. Crusts tend to amplify the faceting process in the snow nearby, and the resultant poor bonding causes avalanche problems.

Unfortunately, recent research shows that our stem thermometers are insufficient to monitor some of the temperature gradients taking place over short distances adjacent to crusts, and our hand lenses and crystal cards do not always allow us to see some of the dramatic changes taking place extremely close to the crust.

The tools that can help us monitor what is going on around the crust are stability tests. Once a crust is buried, we can use stability tests to help us estimate the bonding to the crust and how that changes over time. Certainly, crusts bear watching and monitoring. There is a lot we don't know about crusts, so be sure to note any unusual observations so you can compare what you see with others.

In the near future we may get more opportunities to track tricky crust

scenarios as climate patterns shift and crust-forming events become more common in even our less-maritime environments. So, keep track of those crusts. However, don't assume they will always be a problem. Even with crusts, what I call Ron Perla's First Law of Avalanche Forecasting (the only rule of thumb is that there are no rules of thumb) still applies!

### Acknowledgements

Thanks to Cora Shea for quickly reviewing this at short notice!

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Karl Birkeland is the acting director, avalanche scientist, and currently the sole employee of the Forest Service National Avalanche Center. He loves chasing his two daughters around Bridger Bowl and is hoping that by the time this issue of TAR hits our mailboxes, the early season drought of the winter of 2011/12 will only be a memory. ❄️