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 ➔

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
Cora’s work shows 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 58)

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 sometimes 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
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References


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.