

An Update on the Extended Column Test: New recording standards and additional data analyses

Story by Ron Simenhois and Karl Birkeland

Avalanche release requires both fracture initiation and propagation, but most standard stability tests focus only on measuring fracture initiation. A few indirect methods, such as noting shear quality (*Johnson and Birkeland, 2002*) and/or fracture character (*van Herwijnen and Jamieson, 2004*) for small block tests or the amount of the block released for a rutschblock (*Schweizer and Wiesinger, 2001*), are being increasingly used. Still, no direct measures of fracture propagation existed for practitioners until two such methods were presented at the 2006 International Snow Science Workshop (ISSW) in Telluride. One method was Gauthier and Jamieson's (2006) Fracture Propagation Test. The second was our Extended Column Test (ECT) (*Simenhois and Birkeland, 2006; Simenhois, 2006*).

Since the ISSW we have had an overwhelmingly positive response to ECT, with users around the U.S. and even in the Pyrenees giving us positive feedback about its effectiveness. However, the recording method we originally presented proved to be cumbersome and confusing for many users. In addition, we felt that our original paper, which was based on data collected by only one individual, could be made much stronger with the inclusion of other results from more users. This short paper attempts to address these two concerns by: 1) providing an updated recording standard for ECT results and 2) analyzing additional ECT data collected by numerous individuals in many different snow climates.

An Updated Recording Standard for ECT Results

Discussions with a number of individuals led us to the conclusion that we needed a new recording standard for the ECT. Our main goal in establishing a new standard was to try to emphasize what the test results are telling the user. Our results (*Simenhois and Birkeland, 2006 and below*) emphasize the importance of whether or not a fracture propagates across the entire column (now coded as ECTP) or not (now ECTN), and this needed to be reflected in the way the test results were recorded. In the end we came up with:

ECTPV– fracture propagates across the entire column during isolation
ECTP##– fracture initiates and propagates across the entire column in ## or ##+1 taps
ECTN– fracture does not propagate across the entire column or there are two or more taps between the initiation and propagation of the fracture
ECTNR– no fracture occurs during the test

Assessing the Effectiveness of the ECT with a More Diverse Data Set

➤ METHODS

The growing acceptance of the ECT as well as the use of SnowPilot allowed us to collect more diverse data from different observers and mountain ranges. At the end of the winter we went through the season's

entire collection of pits in the SnowPilot database and identified pits with ECT observations. Overall we found 127 pits from 14 different mountain ranges, six states, and by 14 different observers. We believe this dataset offers an excellent comparison to the better controlled (though not as diverse) dataset used in our ISSW paper (*Simenhois and Birkeland, 2006*).

To decide if a pit is on a stable or an unstable slope in the SnowPilot data we relied on the observer's similar-slopes stability rating, comparable to the methods used by Birkeland and Chabot (2006) for their analysis of false-stable stability tests. If the stability rating was good or higher, we rate the slope as stable, while ratings of poor or very poor put the slope in the unstable category. If the stability was rated as fair or there was no stability rating, we rate those slopes that had no signs of instability or have been skied with localized signs of instability as stable. Otherwise they rate as unstable. Clearly there are some flaws in this system since in some cases it relies on incomplete, subjective, and inconsistent data. The slope rating is not as definitive as the techniques we used to separate out stable from unstable slopes in our ISSW paper (*Simenhois and Birkeland, 2006*). Still we feel the diversity of these data make them valuable and that our technique is reasonable for our analyses.

Out of the 127 pits from SnowPilot, 53 pits (43%) were rated stable, 60 pits (47%) were rated as unstable, and

14 of the pits (10%) were rated as unknown because the data was unclear or incomplete. We limited our analysis to the 113 pits we could characterize as stable or unstable using the technique outlined above.

Another data source included 31 pits from the Pyrenees sent to us by the forecasters from the Catalan warning center. In addition to ECT results, these data included compression or rutschblock tests with shear quality and stability rating from 1 to 5. Out of the 31 pits, eight pits (25%) were on unstable slopes, and 23 pits (75%) were on stable slopes.

In this report we analyze the combined data from SnowPilot and the Pyrenees (SP) totaling 144 pits (76 stable and 68 unstable pits).

➤ RESULTS AND DISCUSSION

As we reported at the ISSW in Telluride, our first season's data (collected by the senior author) demonstrated the effectiveness of the ECT at discriminating between stable and unstable slopes. Of the 68 tests on unstable slopes, the fracture propagated across the entire column on the same or one additional loading step (ECTP) 100% of the time, and for the stable slopes the fracture propagated across the entire column in only four of 256 cases (1.6%) (*Simenhois and Birkeland, 2006*).

Our more diverse SP data set also demonstrated the effectiveness of the ECT for identifying unstable

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This photo was taken at about 11,000' on a 27-degree south-facing slope in the Corral Creek area at Vail Pass. We did not dig a formal pit that day. Traveling tests showed about 10cm of dust on a thin crust, with about 20cm of facets below, on top of another thin crust, on top of about a meter of depth hoar that went to the ground. There was a lot of wind transport on the ridge near Uneva Pass at 12,000'. The top of the bowl had a supportable crust with 20-30cm of wind buff on top, which made for good skiing conditions. Snow

was less and less supportable as we descended. At about 11,000' I came over a roll, the snow at my feet collapsed, and I came to a grinding halt down in the depth hoar. When the snow below me collapsed, it remotely triggered an isolated collapse around this tree stump about 20 meters away. The collapse around the tree stump was an isolated pocket, totally separate from the surface snow I was on.

Photo by Mike Bartholow

EXTENDED COLUMN TEST

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slopes. Of the 68 tests on unstable slopes, 66 tests results in an ECTP, while in only two cases (3%) did the fracture fail to fully propagate across the column (ECTN). This low rate of false stability is encouraging and is less than a third of that reported for stability tests such as the compression test or the rutschblock (Birkeland and Chabot, 2006).

To better understand our two false-stable cases, we discussed them with their respective observers. The first case occurred on December 12, 2006, on a 40-degree slope at Bridger Bowl ski area in Montana in a pit dug by Doug Richmond. Stability on similar slopes was rated as poor, but Doug felt that it was safe to ski this particular slope. When we talked to Doug he said that similar slopes avalanched with control work but this slope didn't. When he dug the pit he felt that stability on this specific slope was good due to a lack of a cohesive slab on top of weak layers but needed to be watched carefully with more precipitation or a wind event. Given these observations, our method of declaring this an "unstable" slope might ultimately be the reason this test was classified as false stable.

The second case was on a 34-degree slope (that steepened to 38 degrees below the pit site) in Idaho's Smoky Mountains on February 23, 2007. On this slope Janet Kellam observed collapses on top of the slope and 5m from the pit. Still, there were conflicting results in her pit. The ECT did not fully fracture (ECTN) and had a Q3 shear quality. However, a rutschblock test in the same pit popped with RB3 and Q1 shear quality. The weak layer was under a melt-freeze crust. No slides were triggered by those collapses or during the day, and Janet felt that the slope probably would not have slid, but it certainly was one of those situations you prefer not to get caught, so she decided to back off and not ski it. This is just one more reason why traveling the backcountry with a smart woman (and the president of the American Avalanche Association) is a good call!

The SP dataset does show a higher rate of false instability than our original data. Of the 76 stable pits, in 12 tests from 10 pits (16%), the fracture propagated across the entire column (ECTP): a rate about 10 times higher than in our original data.

There are a number of possible reasons for the relatively high number of false-instability cases. First and foremost, the data in the SP dataset are not as controlled as the original dataset. The original data involved only one observer applying the same standards to each of his slopes. Further, the delineation between stable and unstable slopes in those data could be better defined since most of the slopes were tested with explosives.

A second possible reason is that the ECT aims to primarily test the snowpack propagation propensity. In order for slabs to release, fractures need to not only propagate, but they must first initiate. In other words, in some cases the snowpack propagation propensity may be high, but fracture initiation is unlikely and therefore stability is high enough that instability could not be observed. This occurred in one of our cases of false instability, where an extremely strong melt-freeze crust overlying moist depth hoar caused the observer to rate the current snow stability as good (despite the ECTP result), though he expected the stability to drop as the crust warmed and thinned.

The low rates of false stability and false instability emphasize the usefulness of the ECT as an additional tool for avalanche professionals. However, the presence of some misleading results highlights the necessity for avalanche workers to use a variety of snow-stability tests and combine those test results with avalanche, snowpack, and weather observations for effective avalanche assessments.

Spatial Variability of Extended Column Test Results

Our ISSW paper reported results from a slope with 21 ECT results. The result of every test on the slope was ECTN, suggesting that, at least for this particular slope, ECT results were spatially uniform (Simenhois and Birkeland, 2006).

This past season we again conducted a spatial array of ECTs, this time on Tucker Mountain in Colorado. The array consisted of a 24-pit grid spanning an area 30m across the slope by 20m down a slightly convex



Figure 1: An overview of the grid of 24 pits on Tucker Mountain in Colorado. The black line marks the lower boundary of the hard slab involved in avalanches on similar slopes two days before our sampling.

slope with a 27-degree slope angle on the upper part of the grid and 33 degrees at the lower part. We rated slope stability as fair, with the same aspect and elevation as other slopes that avalanched two days earlier with explosives and ski cuts. However the slab that avalanched was confined to the top 15m of the ridgetops. In our grid we found similar conditions, with a slab similar to the slab that produced avalanches in the location of the upper 17 pits and a softer slab at the other seven pits (Figure 1). ECT results on this grid were spatially uniform on the top 17 pits and on the other seven pits, but differ between the two groups of pits with ECTP in the top 17 pits and ECTN in the lower seven pits (Figure 2). In the case of these results, there is a clear and explainable reason for the observed spatial variability, which is not always the case for the variability observed for some other tests which focus on fracture initiation (e.g., Landry et al., 2004). Indeed, the variability in ECT results observed appears to reflect the actual stability conditions on this particular slope.

Conclusions

Many different snow-stability evaluation techniques exist. Our results suggest that the ECT is a valuable addition to our stability-assessment toolbox. In particular, we are encouraged by how effectively the ECT identifies unstable slopes, and we are likewise encouraged by the spatial uniformity of ECT results in both stable and unstable areas.

Despite the promising results, we caution that our data are still limited. We have analyzed only two slopes to assess the spatial variability of ECT results so far. In coming seasons we plan to continue investigating the use of the ECT in other locations, with other snowpacks, and with a variety of observers to further validate its usefulness. Also, we remind readers that all stability evaluation techniques must be supplemented by additional information, such as detailed avalanche and weather observations, to effectively evaluate the snowpack stability. We encourage others to try the ECT in addition to their other tests, evaluate its effectiveness, and share their results and experiences with us.

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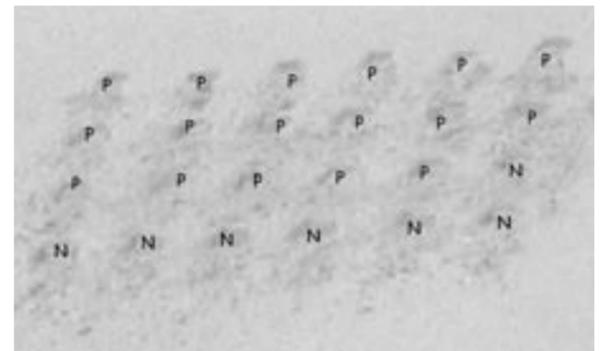


Figure 2: ECT results in the Tucker Mountain grid showing the locations with ECTP results (shown as "P") and locations where the result was ECTN (shown as "N"). An active slab existed only at the upper left part of the grid, which is clearly reflected in the ECT results.

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Acknowledgements

We are extremely grateful for all the help we have received with this work. We would like to thank Copper Mountain Ski Patrol for giving Ron Simenhois the time and the opportunity to collect data during the 2005/06 and 2006/07 seasons. Muchas gracias to Ivan Moner Seira and his colleagues from the Centre De Prediccion De Lauegi Dera Val D'aran for sharing their data from the Pyrenees. A big thanks to Doug Chabot for all his work on SnowPilot and to all the people who submitted their ECT results to SnowPilot last season. Doug Richmond and Janet Kellam shared the details of their cases of false stability with us, allowing us to better understand those cases, and Ethan Greene and Doug Chabot provided great comments and feedback on updating the ECT recording system.

In 2002, Ron Simenhois decided to find a real job. He quit his job developing software, left his home country, Israel, and started ski patrolling in Copper Mountain, Colorado, and Mt. Hutt, New Zealand. This is Ron's first summer since 2003, and he can't wait until the next snowfall. The big event of the summer was that Ron's wife Jenny gave birth to their first child, a healthy baby girl named Tal, which means morning dew in Hebrew.

Karl Birkeland works as the avalanche scientist for the Forest Service National Avalanche Center. In the summer he tries to spend some of his free time on rivers, and in the winter he enjoys chasing his two girls around on skis while he can still (barely) keep up!

