

Avalanche accident case study: Persistent buried weak layer in the Central Idaho Mountains

Doug Abromeit*
Forest Service National Avalanche Center
Bozo Cardozo
Sun Valley Helicopter Ski Guides
Ketchum, Idaho

Abstract: A helicopter ski guide died in an avalanche at 3:00 pm on February 10, 1996 while guiding clients on a large west-facing slope in the Smoky Mountains of Central Idaho. The ski guide, his clients, and several other guides and their clients had skied over one hundred runs in the vicinity and on the same slope prior to the accident. The avalanche measured nearly one half-mile wide and involved three chutes that are separated by counter ridges. Three other guides and sixteen clients were on an unaffected counter ridge when the avalanche occurred.

The avalanche fractured on buried surface hoar and near surface facets. The avalanche varied from one foot to an estimated five feet deep and ran on 28 to 38 degrees slopes. Forty-eight hours of extreme avalanche hazard including many natural and human triggered avalanches followed the fatal accident.

Prior to the February 10 avalanche, significant WNW winds on January 27 rapidly loaded slopes throughout the area and numerous large natural and artificially triggered new snow avalanches occurred. No avalanches were reported from February 4 through February 9. An “inverted” storm dropped several centimeters of snow and three centimeters (1.2 inches) of water equivalent from February 4 - 8. Temperatures rose from -16 degrees C (2F) February 2 to -1 degree C (30F) February 9 and then spiked to 5 degrees C (41F) at 2:00 pm February 10.

Our paper will examine possible reasons why the deadly cycle occurred despite no overly dramatic weather event immediately preceding it, how the accident affected the local community including avalanche education, and possible ways to deal with similar events in the future.

Keywords: avalanche accidents, snow creep, buried surface hoar

1. Introduction

A helicopter ski guide died in an avalanche at 3:00 pm on February 10, 1996 while guiding clients on a large west-facing slope near Paradise Peak in the Smoky Mountains of Central Idaho.

Sun Valley Resort epitomizes the Central Idaho Mountains’ major winter weather pattern, sun and high pressure. The Central Idaho Mountains include the Sawtooth, Boulder, Pioneer, and Smoky Ranges. Warm Pacific moisture from low-pressure south to southwest flows produces most of the area’s Spartan five meters (200 inches) of average annual snowfall.

Corresponding Author Address: Doug Abromeit,
PO Box 2086, Hailey, ID 83333 USA;
208.622.0088; email: dabromeit@fs.fed.us or
douga@sunvalley.net



Figure 1: State of Idaho with the village of Sun Valley and the Central Idaho Mountains

Colder high-pressure west to northwest flows typically replace the low-pressure flows and produce long periods of sunny days and cold clear nights; the cook's recipe for surface hoar and near surface facet formation.

2. Weather Conditions

This typical high-pressure weather regime dominated Central Idaho Mountain weather the last two weeks of December 1995 and it produced surface hoar on top of depth hoar and near surface facets. A rather large Pacific low-pressure system moved over Central Idaho around January 1, 1996. This low produced significant snow and was followed by northwest winds that reached 145 kilometers per hour (90 mph). The combined snowfall and winds deposited thick slabs on south and east tending aspects.

Two young men carrying snowboards died in an avalanche January 5, 1996 near Galena Pass in the Boulder Mountains north of Sun Valley, Idaho. The men triggered the avalanche on a low angle slope when they crossed a thin weak spot in the snow-pack and it collapsed and propagated to a 102 centimeters (40 inches) thick hard slab on a 45 to 50 degrees southeast-facing slope directly above them. The hard slab fractured on the recently buried December layer of near surface facets and surface hoar. Neither a third person that had uneventfully crossed the same path on skis moments before the avalanche nor the victims carried a transceiver, shovel or probe pole.

Around 178 centimeters (70 inches) of snow fell during the remainder of January. Significant WNW winds on January 27 rapidly loaded slopes and numerous large new snow avalanches were observed for several days following the storm.

During this period of new snow avalanches there were no reports of avalanches fracturing on the December surface hoar layer and only one report of a new snow avalanche stepping down into the December weak layer. That avalanche was a very large east-facing natural that fractured in new snow around 2926 meters (9600 feet). The avalanche accumulated a massive amount of debris and descended 488 meters (1600 vertical feet) before it stepped into the December buried surface hoar layer.

An "inverted" storm dropped several centimeters of snow and three centimeters (1.2 inches) of water equivalent from February 4 through February 8.

Rain fell to 8000 feet on February 8. No natural or artificially triggered avalanches were reported from February 4 through February 9.

The high temperature rose from -16 degrees C (2F) on February 2 to -9 degrees C (15F) February 3 and continued a daily rise until it hit -1 degree C (30F) February 9. Low temperatures were typically around -3 or -4 degrees C (low to mid 20's F).

3. Avalanche and Accident Description

Sun Valley Helicopter Ski Guides scheduled four guided groups for Paradise Peak on February 10. Paradise Peak is located about 25 miles west of Sun Valley in the Smoky Mountains. The Ski Guides had made eight previous reconnaissances and guided trips to the area.



Figure 2: The Smoky Range and Paradise Peak (center background)

Four guides and sixteen clients flew to the Paradise Peak area on the morning of February 10. The guides performed ski cuts, dug hasty pits and conducted shovel shear tests on a variety of aspects and elevations throughout the day. The guides reported their ski cuts did not trigger any slides and they did not see cracking or hear collapsing noises. Their shovel shears were mostly *easy* at 25 to 38 centimeters (10 to 15 inches) in the new snow and mostly *moderate* at 61 to 91 centimeters (24 to 36 inches) in the December weak layer. No Rutschblock, compression, or stuff block tests were performed. One guide reported *very strong, dense (pencil hard) wind waved snow across the entire west face*. The guides concluded from their ski cuts, observations, and shovel shear tests that *stability was fair for the new snow and good for deep slab**.

*Avalanche Accident Report, Sun Valley Helicopter Ski Guides, March 1996.

Most of the morning's skiing occurred on east aspects. A client triggered a cornice release about 1:00 pm while walking on shallow snow near rocks on a 2926 meters high (9,600 feet) ridge top above Emma Creek. The large section of cornice rolled down a steep east face.

A small slab released sympathetically or spontaneously at about the same time. The small slab started at 2499 meters (8,200 feet) on the lower 1/3 of an adjacent southeast slope and traveled 122 meters (400 vertical feet) to the valley floor. This small avalanche mirrored the guides' forecast for possible sun induced surface avalanches at lower elevations. The guides shifted all skiing to west aspects immediately following the cornice release and small slab avalanche.

Four groups of guides and clients had made about 80 individual runs on mostly east and west aspects in and around Paradise Peak by 2:30 p.m. At 2:30 p.m. three of the four groups were skiing in close proximity of each other on a west-facing slope above Emma Creek (the fourth group had opted to return to town). One group was at 2926 meters (9600 feet) on the top of the main ridge and the other two groups were on a convex west-facing counter ridge, one at about 2774 meters (9100 feet) and another at about 2591 meters (8500 feet).

The guide at 2774 meters told his group, since the group lowest on the slope was in a safe location that he (the guide) would ski into an adjoining chute and ski down to the lowest group. The group reported the guide crossed a thin section on the counter ridge before entering the chute. The section the guide likely crossed was about 36 centimeters (14 inches) of mostly faceted snow with tufts of grass sticking from it. The guide had gone out of sight of his group when a large avalanche roared down the chute and engulfed him.

The avalanche fractured on the December layer of buried surface hoar and near surface facets. The avalanche was about 600 meters (1980 feet wide) and 800 meters (2640 feet) long with crown faces from about 30 centimeters (one foot) to 150 centimeters (five feet) thick. The avalanche ran from about 2925 meters (9400 feet), 90 meters (300 feet) below the top of the ridge, to 2377 meters (7800 feet) near Emma Creek. The avalanche included three distinct chutes separated by shallow convex counter ridges. All three chutes had been skied prior to the accident and they had an estimated 30 tracks on them. The guide was skiing in the shortest and northern-most chute. Slope angles in

the chutes varied from about 38 degrees to 28 degrees.

The pilot had landed the helicopter near the northern-most chute and slightly upslope of the meadow that Emma Creek runs through. The pilot did not see the avalanche start but he did see debris exit the southern-most chute first, the middle chute next, and the northern-most chute last. Several members of the group lowest on the slope reported hearing a loud noise. All members reported seeing three to 4.5 meters (10 to 15 feet) of debris traveling at an estimated 80 to 100 kilometers per hour (50 – 60 mph) pass by them in the adjacent chute. The lower group's guide did not hear the loud noise.

The remaining two guides quickly gathered and secured all the clients and began a beacon search. They recovered the buried guide 15 minutes after the avalanche and had him airborne very shortly afterward. The guide was declared dead at the Sun Valley hospital.



Figure 3: The three southern-most chutes. The guide was buried in a chute just out of the photo to the left.

The fatal avalanche occurred about 3:00 pm. Several people subsequently reported loud collapsing noises and natural and human triggered avalanches that occurred at about the same time in various locations, elevations and aspects throughout the Central Idaho Mountains.

One notable incident occurred at a National Avalanche School field session that was taught on Titus Ridge six miles northeast of the accident site. A student on roped belay triggered a large avalanche on an east facing 40 degrees slope at 3:05 pm, five minutes after the fatal avalanche. The student was jumping up and down on skis to stress test the snow-pack when she triggered an avalanche with a crown about one and one-half meters deep and about 100 meters (325 feet) wide that ran about 300 vertical meters (975 feet). The avalanche fractured on buried surface hoar and near surface facets. The avalanche fractured about two feet down slope from the student and did not injure the student.

4. Temperatures and Crown Profile

The Titus Ridge remote weather station sets on a ridge similar to the accident site. Titus is located about 9.5 kilometers (six miles) northeast of Paradise Peak showed the temperature dropped to -11 degrees C (12F) the night of February 9 and then rose to 5 degrees C (41F) on February 10. The overnight low at Titus was the lowest since February 3 and the high was six degrees C (11F) warmer than the previous day and the highest temperature since January 12.

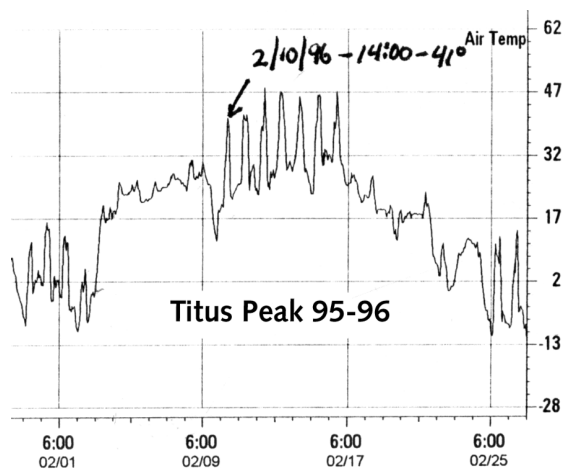


Figure 4: Temperatures from Titus Peak Weather Station

The Vienna Peak SNOTEL site located mid-slope at 2745 meters (9,000 feet) 6.5 kilometers (four miles) north of Paradise Peak recorded an overnight low of -10 degrees C (13F) the night of February 9 and a high of 2 degrees C (35F) on February 10. Prior to February 10 highs and lows at Titus and Vienna had been quite similar.

The Soldier Mountain Cat Ski weather station located at 2745 meters (9,000 feet) 29 kilometers (18 miles) south of Paradise Peak recorded an overnight low of -4 degrees C (24F) the night of February 9 and a high of 2 degrees C (35F) at 3:00pm February 10.

The day after the accident Forest Service and Sun Valley Helicopter Ski Guides personnel flew to the site. They noticed several natural avalanches that occurred the afternoon before. The helicopter they were riding in triggered a large avalanche on an east-facing slope when it landed on the ridge top above the fatal west-facing avalanche.

The group conducted a crown profile in the chute where the accident occurred. The crown profile showed a one finger dry slab 110 centimeters thick that sheared easily on buried surface hoar and near surface facets. No other profiles were gathered because of the very unstable snow-pack.

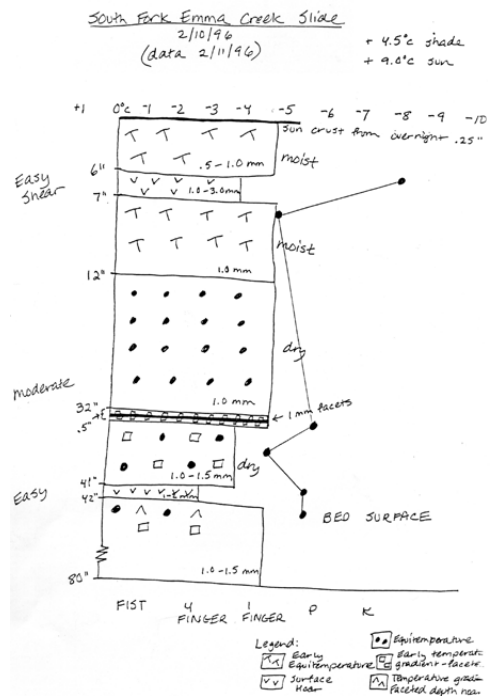


Figure 5: Scanned copy of crown profile taken February 11 (the day following the avalanche).



Figures 6: Photo of the crown in the northern most chute.

Sun Valley Helicopter Ski Guides dropped two explosive charges from the helicopter as it left the accident site. Both charges triggered large avalanches on west-facing slopes adjacent to the accident site. They also observed numerous natural avalanches on all aspects and especially on those facing east and west.

High temperatures remained around 7 to 8 degrees C (mid to upper 40'sF) from February 10 (the day of the fatal avalanche) through February 16. The cycle of large natural and artificially triggered avalanches fracturing on the December surface hoar layer continued during this period. High temperatures dropped to around -4 degrees C (mid 20'sF) on February 17 and continued dropping through the end of the month, as did the avalanche danger.

5. Accident Report

The Forest Service compiled a report that chronicled the events leading up to the accident and concluded:

1. *(That) the rise in temperatures both that day and throughout the week (may have) increased creep and glide in the slab...(which) increased stress on the buried surface hoar layer.*
2. *(The guide) may have collapsed the (snow-pack) at a weak point and caused a brittle failure that propagated above him and triggered the avalanche in the three chutes*.*

*Forest Service Avalanche Fatality Report, March 5, 1996.

6. Conclusions

Assigning a definitive explanation to an avalanche cycle is often difficult. The conclusions reached in the Forest Service Accident Report seem logical.

All the necessary conditions for slab avalanche formation existed (steep enough terrain, weak layer, overlying slab, and spatial thickness variations). The warm temperatures optimized the deformation of the slab and the weak layer and promoted *creep induced local weak spot formation**.

The three centimeters (1.2 inches) of water equivalent that fell February 4 through February 8 may also have been a major factor in the cycle. This amount of water over four days typically would not dramatically affect a stable snow-pack. However, a persistent and widespread weak layer of buried surface hoar and near surface facets existed in the Central Idaho Mountain snow-pack.

Perhaps the stress on the weak layer from the 1.2 inches of water combined with the stress from creep and glide in the slab tipped the delicate balance.

7. Questions

Nevertheless, several questions come to mind.

- Significant winds and snow rapidly loaded slopes on January 27 and numerous large new snow avalanches occurred for several days afterwards. Why didn't this event trigger avalanches in the December weak layer?
- February 4 through February 8 three centimeters of water equivalent fell. Why weren't there any natural or artificially triggered avalanches (reported) during this period?
- The widespread cycle began around 3:00 pm February 10 and affected slopes with a variety of aspects many miles from the accident site. Why did the cycle begin when it did and why was it so widespread?

*Review of the Forest Service Avalanche Fatality Report, Dr. Hansueli Gubler, March 26, 1996.

8. Community Effects

The two young men killed in the January avalanche were both 19 years old and both had both grown up and gone to school in Ketchum, Idaho. They were home on Christmas Break from college when the avalanche occurred. They were only minutes away from a backcountry skiers' parking lot on Galena Pass when they were buried. The brother of one of the victims was with them and witnessed the event but he was unable to locate and rescue his brother and his friend.

The ski guide lived in Hailey, Idaho and worked for both Sun Valley Helicopter Ski Guides and the Sun Valley Ski Patrol in the winter and as a river guide in the summer. His wife also worked for Sun Valley Ski Patrol and she was the dispatcher when the call came that a person had been caught and buried in an avalanche at Paradise Peak.

The three men were very well liked and well known. Their deaths profoundly saddened the local community. Members of the community were shocked both that an avalanche in sight of one of the area's most popular winter trail heads could kill two vibrant young people and that a backcountry avalanche could catch and kill a knowledgeable and skilled guide.

The deaths of the young men and of our very good friend and colleague served as a poignant reminder of how serious, dangerous and unforgiving our profession can be.

Citizen involvement in and support for the Sawtooth National Forest Avalanche Center daily advisories and avalanche education classes increased significantly following the three deaths.

Acknowledgements

Thanks to Karl Birkeland of the Forest Service National Avalanche Center and Kim Jacobs and Pete Pattersen of Sun Valley Helicopter Ski Guides for reviewing this paper.

References

- Blaine Country Sheriff. 1996. Offense Report Hailey, Idaho.
- Forest Service National Avalanche Center. 1996. Avalanche Fatality Report: Sun Valley Helicopter Ski Guides. Ketchum, Idaho.
- Friedman, M. Personal communication. Helicopter Ski guide and film maker. Telluride, Colorado.
- Galena Nordic Patrol. 1996. Galena Avalanche Accident Report. Ketchum, Idaho.
- Gubler, H. 1996. Personal letter to Steve Diehl discussing the Forest Service Avalanche Fatality Report.
- Sun Valley Helicopter Ski Guides. 1996. Avalanche Accident Report. Ketchum, Idaho.