

COLORADO GEOLOGICAL SURVEY

ROCK TALK

VOLUME ONE, NUMBER FOUR

OCTOBER, 1998

COLORADO AVALANCHE INFORMATION CENTER: A SHORT HISTORY

It is estimated that 20,000 avalanches fall annually in Colorado. A small percentage of these affect people, property, and highways. Every winter about 60 people are reported caught by avalanches, six are injured and six are killed. Additionally, avalanches cause about \$100,000 in direct property damage and cause indirect economic losses of \$3–5 million. (For example, a large storm on a Saturday could trigger avalanches onto highways, preventing 10,000 skiers from reaching ski resorts and resulting in revenue loss of \$500,000.) Another 300 avalanches a year, many released with explosives by Colorado Department of Transportation (CDOT), hit state-managed highways.

Why an Avalanche Center?

Avalanches, therefore, pose a significant hazard to industry, residents, recreationists, and travelers. An efficient and cost-effective program that monitors conditions and assesses the hazard is key to mitigating the danger statewide.

Origins

The seed that grew to be the Colorado Avalanche Information

Center (CAIC) was sown in 1973. That year the U.S. Forest Service avalanche project in Fort Collins



Powder avalanche in motion

formally launched a pilot forecast program for Colorado. It was the first avalanche forecast program in the U.S., and it enjoyed 10 successful years.

However, in 1983 the project lost its funding. In those years, avalanche research in the Forest Service was a low priority and the Avalanche Warning Program was abolished as a first step in disman-

ting the entire research project. But riding in like a white knight was the Colorado Department of Natural Resources to offer the program a new home in the Executive Director's Office . . . as long as it could raise its own money. It did so, but barely. The savior proved to be the Forest Service, which provided a lifesaving grant.

The CAIC: A New Name and New Mission

Upon entering state government, the program adopted a more service-oriented mission that stressed not only avalanche forecasting but also public education. To reflect its expanded mission, the program was renamed the Colorado Avalanche Information Center.

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Field Notes from the State Geologist

Avalanches—The Most Dangerous Geologic Hazard in Colorado

The Colorado Department of Natural Resources 1991–95 Plan contained the following statement as one of the goals for the Colorado Geological Survey (CGS): “To minimize or prevent environmental damage, loss of life, adverse financial impacts or destruction of resources as a result of geologic hazards or energy and mineral development.”

The program within the CGS that is concerned with the geological hazard most deadly to people in our state is the Colorado Avalanche Information Center. Avalanches pose a significant threat to people living and working in Colorado. Each winter, on average, avalanches kill six people and cause economic losses totaling millions of dollars. Given the inherent risks taken by many back-country skiers, snowboarders, snowmobilers, and snowshoers, it is unrealistic to expect the CAIC to be able to eliminate fatal avalanches. Nevertheless, the number of victims can be minimized with a program that informs and educates the public about the potential hazard. Additionally, the possibility of an avalanche disaster along a Colorado highway or at a developed site will always be present, but the probability of it happening can be reduced to near zero with a state-of-the-art avalanche center.

continued on page 3

THE CAIC: ITS PEOPLE AND OPERATIONS

The work of the CAIC is tied to the seasons—specifically, avalanche season. From November through April, the Center is fully staffed for forecasting and educational services, and operates seven days a week. From May through October, the Center closes its forecast operations and maintains a smaller staff that provides management, fund-raising, data compilation and reporting, and other necessary services.

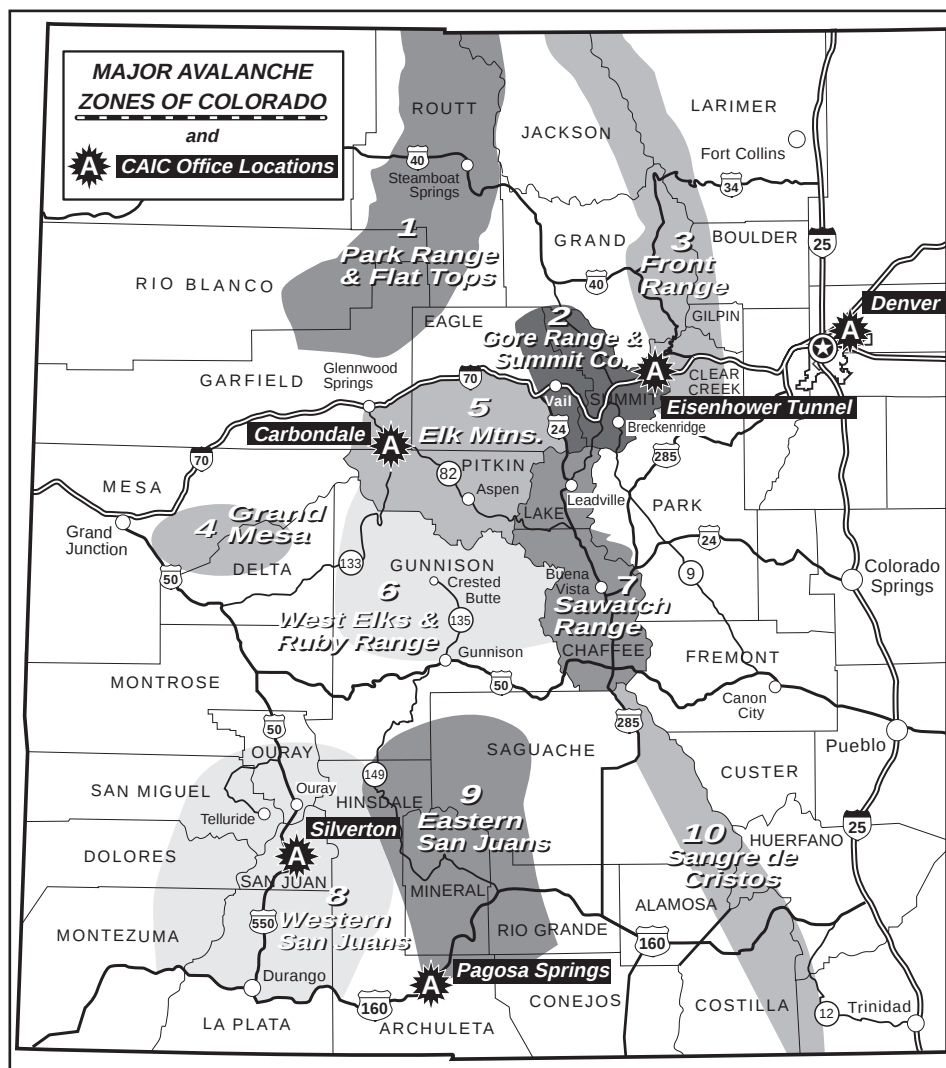
Purposes

The chief functions of the Center are to:

- monitor changing snow and avalanche conditions,
- provide daily hazard evaluations and forecasts,
- warn of dangerous avalanche conditions,
- advise CDOT of avalanche potential along state highways,
- provide avalanche safety education and outreach, and
- be the state’s focal point for avalanche information.

Forecast Services

The Denver office of the CAIC is located at the National Weather



Colorado avalanche zones and CAIC offices

Service. The staff includes Knox Williams, Nick Logan, Dale Atkins, and Scott Toepfer. Collectively, this staff has about 95 years of avalanche experience. Throughout the winter season, this team shares the duties of lead forecaster who, on a daily basis, is responsible for:

- gathering, logging, and analyzing data from about 40 staffed sites (e.g., ski areas and highway passes) or remote weather stations,
- issuing snow stability evaluations and forecasts for 10 mountain zones and five highway locations (see map on page 2),
- disseminating those forecasts to the public and user groups via hotlines, fax, and e-mail,
- issuing formal Avalanche Warning Bulletins, when warranted,
- responding to calls from the news media, and
- handling special requests from sponsors/clients.

Highway Forecast Offices

The CAIC staffs four mountain offices to provide forecasting and training services to CDOT (see map on page 2).

- **Silverton:** Andy Gleason and Doug Lewis forecast for U.S. 550 from Coal Bank Hill to Red Mountain Pass, Colorado 145 over Lizard Head Pass, and Colorado 110.
- **Pagosa Springs:** Mark Mueller forecasts for U.S. 160 over Wolf Creek Pass, U.S. 50 over Monarch Pass, and Colorado 17 over Cumbres and La Manga Passes.
- **Eisenhower Tunnel:** Forecasters Lee Metzger and Cathy Fraser are responsible for the I-70 corridor from Georgetown to Vail, U.S. 6 over Loveland Pass, U.S. 40 over Berthoud Pass, and (in the spring) Colorado 82 over Independence Pass.
- **Western Slope:** Based in Carbondale, Rob Hunker forecasts for Colorado 133 over McClure Pass, Colorado 65 on Grand Mesa, Colorado 139 over Douglas Pass, and Colorado 24 on Battle Mountain.

Education, Publications and Outreach Services

The CAIC provides avalanche safety courses for citizens, tourists,

and avalanche practitioners statewide. Annually the staff offers about 70 classes to more than 3,000 people. In recent years the CAIC has produced two educational videos and published a major study of avalanche accidents entitled *The Snowy Torrents*. Every year the staff writes numerous articles for magazines and newsletters, and averages about 200 contacts seasonally to provide timely and accurate information to broadcast and print media.

—Knox Williams



How to contact the CAIC

Mail: Colorado Avalanche Information Center
10230 Smith Road
Denver, CO 80239

Phone: 303-371-1080 (office)
303-371-5508 (fax)

E-mail: caic@rmi.net

Web: www.caic.state.co.us

Field Notes from the State Geologist—continued from page 2

The CAIC has achieved much with very limited resources. Overall revenues have increased the last 10 years due to of a sizable contract from the Colorado Department of Transportation to provide forecasting and training services for CDOT employees. Cash funding in inflation-adjusted dollars, however, has actually decreased from 1987 to 1997, and these are the dollars needed to provide services to the public (i.e., backcountry users), ski industry, and local and county governments. At the same time, the CAIC

has seen demand for its service—especially education—increase.

The CGS Advisory Committee recently wrote, "The CGSAC believes that it is appropriate and timely to begin supporting the state's avalanche forecasting and outreach efforts, even though the CAIC has not previously received Severance Tax funding. Currently, the only funding support for the backcountry avalanche forecast and education effort comes from donations—from individuals as well as local governments and companies. In essence this program, which has a proven track record in saving lives, exists on volunteer donations. Severance Tax funding will make the state a

partner in this life-saving endeavor." Likewise, the Colorado Mining Association and the Minerals, Energy and Geology Policy Advisory (MEGA) Board have both endorsed providing funding to the CAIC backcountry avalanche forecast and education effort from the state Severance Tax.

New funds for the backcountry forecast and education effort will give the CAIC the opportunity not to expand its mission but rather to fulfill it. With Severance Tax funding, the CAIC is in a position to provide a higher level of service that will benefit everyone who lives in or travels through Colorado's avalanche country.

AVALANCHE HOTLINES AND DANGER SCALE

The CAIC maintains hotlines in seven cities and towns (see box below). Each hotline has a local sponsor who shares the cost of service. The hotlines are updated daily and contain the most recent local weather, snow and avalanche conditions—information valuable for planning back-country trips. Last season the public made more than 76,000 calls to these lines. Actual usage is certainly greater since some systems do not count calls.

Denver	303-275-5360
Colorado Springs.....	719-520-0020
Fort Collins	970-482-0457
Summit County	970-668-0600
Durango	970-247-8187
USFS-Aspen	970-920-1664
USFS-Vail	970-827-5687

When you call one of the hotlines, you will learn the present avalanche danger level. The danger rating can vary from one mountain zone to another and is based on local weather, snow and avalanche data. It can change from one day to the next ... and often does. The International Avalanche Danger Scale (see table) is used by all the avalanche centers in the U.S. and Canada and is very close to that used in Europe.

—Knox Williams

Danger Level	Avalanche Probability	Extent of Instability
LOW	Natural avalanches very unlikely. Human-triggered avalanches <i>unlikely</i> .	Generally stable snow. Isolated areas of instability.
MODERATE	Natural avalanches unlikely. Human-triggered avalanches <i>possible</i> .	Unstable slabs possible on steep terrain.
CONSIDERABLE	Natural avalanches possible. Human-triggered avalanches <i>probable</i> .	Unstable slabs probable on steep terrain.
HIGH	Natural and human-triggered avalanches <i>likely</i> .	Unstable slabs likely on a variety of aspects and slope angles.
EXTREME	Widespread natural or human-triggered avalanches <i>certain</i> .	Extremely unstable slabs certain on most aspects and slope angles. Large destructive avalanches possible.

Upcoming Events Involving CGS

October 10–11

Colorado Snowmobile Expo National Western Complex, I-70 and Brighton Blvd., Industrial Expositions, Inc., (303) 892-6800

October 12–16

Earth Science Week Open House at the Colorado Geological Survey, 1313 Sherman Street, Room 715, Denver, (speakers, display in the Capitol rotunda, handouts) Katie KellerLynn, (303) 866-2611

October 29–30

Geologic Hazards and Engineering Practices in Western Colorado Conference/Field Trip, sponsored by Colorado Geological Survey, Hotel Colorado, Glenwood Springs, (303) 866-2611 for information and registration (see p. 9 and 10)

CAIC: A Short History continued from page

In 1983 the CAIC moved its forecast operation into the National Weather Service office in Denver. And thus it began its first season (1983–84) with a shoestring budget and a staff of four part-timers.

Three subsequent events have shaped the CAIC: 1) in 1987, it moved into the Colorado Geological Survey (CGS), a logical move since avalanches are defined by state statute as geologic hazards; 2) in 1992, it entered into a contractual partnership with CDOT to provide avalanche hazard forecasts for all state and federal highways in Colorado; and 3) in 1995 the Legislature passed—and Governor Romer signed—HB 1314 that formally gave statutory authority to the CAIC within the CGS.

The mission of the CAIC is stated formally as: “The CAIC promotes safety by reducing the impact of avalanches on recreation, industry, and transportation through a program of forecasting and education.” Less formally we say, “The CAIC doesn’t make rules, enforce laws, collect fines, or review, regulate, legislate, control, oversee, withhold, open, or close anything. Instead, our purpose is simply to look out for the safety of people living, working, playing and traveling through Colorado.”

To get the job done, the CAIC relies totally on funding by contracts, grants and donations. Last year more than 50 federal, state, and local government agencies; corporations; businesses; clubs; foundations; rescue teams; and a recently-founded grassroots “Friends” association contributed to the cost-sharing of the CAIC. Additionally, the Center receives fees for its avalanche courses, and it gets huge in-kind support from the National Weather Service in the form of office space, access to data, use of forecast work stations, and access to NWS expertise.

—Knox Williams

EDUCATION CAN SAVE LIVES

While the CAIC cannot prevent all avalanche accidents, it can reduce injuries, deaths and economic losses due to avalanches. The key is education. An educated public and work force will recognize and avoid (or mitigate) the threat of avalanches during the most dangerous times, while the uneducated will be unaware and vulnerable. Therefore, the CAIC offers extensive outreach to promote avalanche safety.

- **Avalanche seminars:** CAIC forecasters conduct 60–80 courses per year to teach avalanche awareness, safe travel and survival skills. These range from 2-hour introductory slide talks to multi-day on-snow seminars. (Call the Center this November to get a list of courses available for 1998–99.)
- **Safety brochure:** A new avalanche awareness brochure will be available this fall. Produced by a donation from the Ethan Gell Memorial Fund, it will teach readers how to recognize avalanche terrain, how to test for unstable snow, how to travel safely in avalanche terrain, and how to improve survival chances if caught in avalanches.
- **Videos:** CAIC staff has helped write and produce three avalanche safety videos. *Avalanche*

Awareness: A Question of Balance (1987) teaches basic avalanche safety, *Avalanche Rescue: Not a Second to Waste* (1992) teaches organized rescue techniques, and *Avalanche Rescue Beacons: A Race Against Time* (1995) (CGS IS 38) teaches the techniques of beacons and small-party rescue.

- **Publications:** The CAIC forecasters write and publish articles for magazines and newsletters. In 1996 *The Snowy Torrents* (CGS SP 39) which is an absorbing study of avalanche



accidents, was published.

- **The Beacon:** This is the CAIC's newsletter for its Friends association. Published three times a year, it covers current events, human interest stories, and avalanche science. Become a Friend and you'll get it! (See article below.)

Contact the CAIC for more information about these educational resources or see the sidebar "How to Order CGS Publications".

—Knox Williams



BE A FRIEND!

FRIENDS OF THE CAIC is the grassroots support group of the Center. For a small annual donation that helps fund the back-country forecasting efforts of the CAIC and its hotlines, Friends receive *The Beacon* newsletter, get the daily forecast via E-mail, if they wish, and get their avalanche questions answered by E-mail. This personal service is a steal at \$25 per year. It's easy to join. Just send your check for \$25 (or more) payable to "Friends of the CAIC" to CAIC, 10230 Smith Road, Denver, CO 80239. Be sure to include your mail address, phone, and E-mail (if you have it), and you'll receive a cool CAIC bumper sticker.

How to Order CGS Publications

Bulletin 49

Snow-Avalanche Hazard Analysis for Land-Use Planning and Engineering \$12.00

Information Series 38

Avalanche Rescue Beacons: A Race Against Time (VHS video) \$25.00

Information Series 46

Snow & Avalanche: Annual Report 1997–98, Colorado Avalanche Information Center \$5.00

Miscellaneous 30

The Avalanche Book (history, causes, terrains, weather, safety, survival, rescue, control techniques, law, studies) \$17.00

Special Publication 7

Colorado Avalanche Area Studies and Guidelines for Avalanche-Hazard Planning \$8.00

Special Publication 12

Nature's Building Codes—Geology and Construction in Colorado (includes building in avalanche prone areas) \$4.00

Special Publication 39

The Snowy Torrents—Avalanche Accidents in the U.S., 1980–86 \$16.00

HOW TO ORDER PUBLICATIONS

Mail: Colorado Geological Survey,
1313 Sherman Street,

Room 715, Denver, CO 80203

Phone: (303) 866-2611

Fax: (303) 866-2461,

E-mail:

katie.kellerlynn@state.co.us

Website:

www.dnr.state.co.us/geosurvey

VISA® and MasterCard® are accepted

SHIPPING AND HANDLING

Shipping and handling will be charged for all mailed orders. Please contact the CGS for shipping and handling costs.

DISCOUNTS

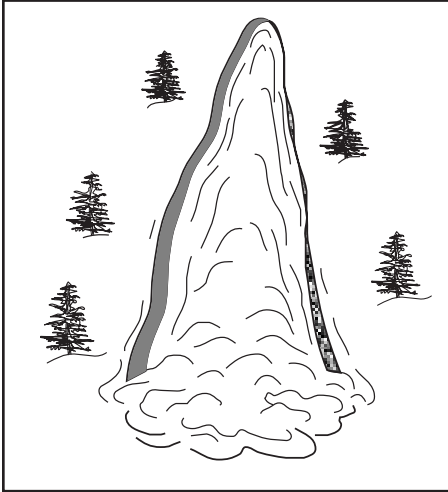
Available on bulk orders.

Call for a complete publication list

AN AVALANCHE PRIMER

Types

Avalanches come in two types: loose-snow and slab. Loose-snow avalanches (also called point-release) occur in a snow cover that has little or no cohesion. They start at a point and fan out as they slide downhill. Though numerous,



Loose-snow or point-release avalanche

they are generally small and harmless, but can become large, especially in wet snowpacks.



Loose-snow avalanche in motion

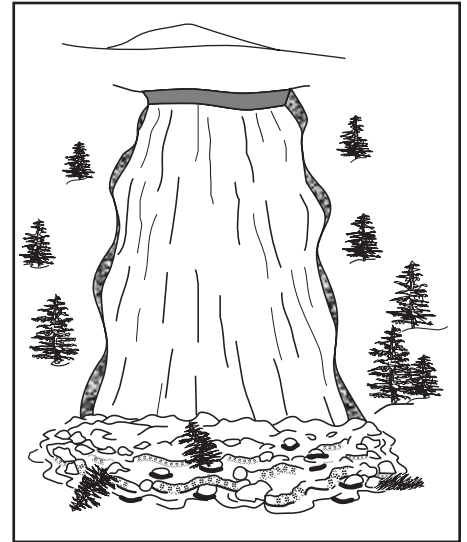
Slab avalanches form and release in a snow cover that is cohesive. Each snow grain bonds to its neighbor, forming a slab layer. The slab can hold itself in place until stress exceeds strength, causing the slab to fail and an



Fifteen-foot crown of large slab avalanche

avalanche to release. Slab avalanches are far more dangerous than loose-snow avalanches because they move more snow at higher speeds and forces.

Both loose-snow and slab avalanches can form in dry, damp, or wet snowpacks.

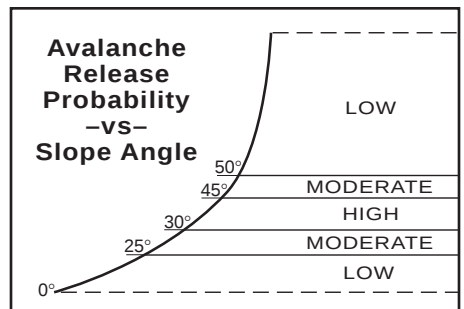


Slab avalanche

Ingredients

There are four ingredients of a slab avalanche:

Slope: 90 percent of avalanches release on slopes of 30–45 degrees. It is this range of slope angles that produces the most critical balance between stress and strength.

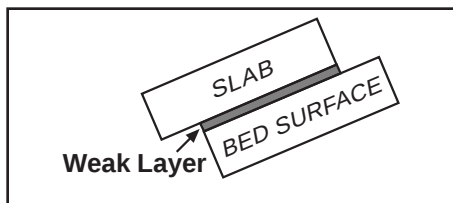


Slab: A cohesive layer of snow that is under stress as gravity tries to pull it downhill becomes the material for an avalanche.

Weak layer: For an avalanche to release, there must be a layer beneath the slab that slips (shear failure) or collapses, making it much easier for the slab to break loose from its final anchors at the top and sides.



*Three-foot
crown
(fracture line)
of slab
avalanche*



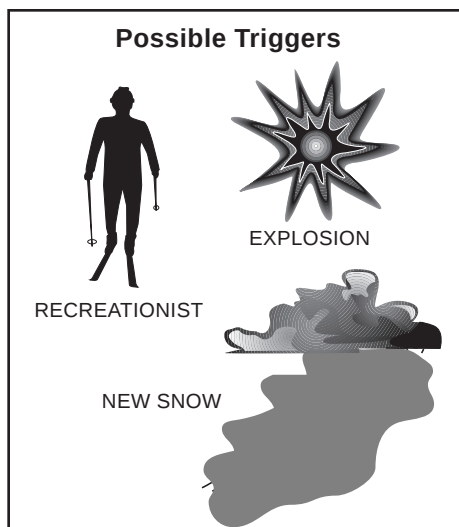
Trigger: A trigger is the additional load of new snow, falling cornice, animal, person, or explosive charge that tips the balance of stress to exceed strength.

Once the trigger causes the weak layer to fail (via shear or collapse), slab tensile stress suddenly increases, and tensile cracks shoot through the slab. The slab starts to slide away and accelerates down the track. The slab blocks break into chunks and particles, and the faster avalanches throw a powder cloud into the air that moves ahead of the denser snow flowing along the ground.

Small avalanches may fracture 1–2 feet deep and 50–100 feet wide, and travel at 30 mph; medium avalanches may break 3–6 feet deep and 200–500 feet wide, and move at 50–60 mph; large avalanches can be 6–10 feet deep, thousands of feet wide, and roar along at more than 100 mph. Large avalanches may set more than 500,000 cubic meters of snow in motion, and have impact pressures that exceed 10 tons/m², these

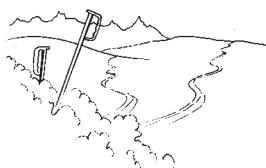
avalanches can snap or uproot mature trees and destroy buildings.

For victims caught in avalanches, it is hard to fight the forces of even small ones. Tumbling downhill, fast and out of control, is never healthy. And if buried, victims can seldom dig



themselves out of snow that often sets up like concrete. Avalanches are best viewed from a distance, of course, so as to appreciate their power and beauty without being so close as to be touched by their malevolence.

—Knox Williams



CAIC Advisory Committee, 1997–98

Vicki Cowart, Colorado Geological Survey; Lanny Grant, Colorado Snowmobile Association; Scott Messina, Mountain Rescue Aspen; Marian Smith, Garfield County Commissioner; Chuck Tolton, Copper Mountain Patrol; Ed Fink, Colorado Department of Transportation; Melanie Mills, Colorado Ski Country USA; Dave Stark, U.S. Forest Service; Mel Wolf, Colorado Snowmobile Assoc.; Leigh Yule, Summit Huts Association

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Vickie B. Pierce, Administration and Outreach
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Knox Williams, Colorado Avalanche Information Center

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GIS and Technical Services

Cheryl Brchan, Matt Morgan, Larry Scott

Mineral Fuels

Wynn Eakins, Tom Hemborg

Colorado Geological Survey

1313 Sherman Street, Room 715
Denver, CO 80203

Phone: (303) 866-2611

Fax: (303) 866-2461

Website: www.dnr.state.co.us/geosurvey

WINTER OF 1997-98 IN REVIEW

A year ago the talk of El Niño had inflated nearly everyone's expectations for snow in Colorado. The CAIC forecasters had different expectations. Review of snowfall records showed no strong correlation between El Niño and winter weather, though there was a bias toward a drier winter. One trend that emerged was that the early and middle winter (November through February) was frequently dry, but the spring months of March and April were snowy. This would mean a thin, unstable snow cover with lots of depth hoar (weak faceted sugar-like snow) for most of the winter to be followed by spring-time deep snows and a few big avalanches. That's pretty much what happened.

Here's a month-by-month replay:

October: Colorado's dry fall ended suddenly in late October when a massive storm clobbered the entire state and an extraordinary wind storm leveled 20,000 acres of timber on Buffalo Pass near Steamboat Springs.

November: Abundant snows fell in the San Juan and Elk Mountains from subtropical moisture from California, but much of the northern mountains were rather dry. Avalanches were frequent but small.

December: Storms passed either north or far to the south of Colorado, so snowfall with few exceptions was well below normal. The season's first fatal avalanche occurred on the 30th, when a snowshoer died in a small hard-slab avalanche only a snowball's throw away from his cabin on Guanella Pass.

January: The West Coast storms finally reached Colorado and brought above-normal snows to the north and central Colorado mountains, while in the southern mountains drier conditions prevailed. January was an especially dangerous month as snow conditions and peoples' attitudes created a potentially lethal

combination. In January alone, avalanches caught 43 people (about the same number of people caught in an average winter), but remarkably only one died—a back-country snowboarder near Lizard Head Pass. Conditions were building for big avalanches.

February: Avalanche workers anticipated a punishing February, but it never came. There were no significant avalanche events. Storms split around Colorado, and just enough moisture flowed in to fuel frequent but light snowfalls. The mountain snow cover was a fragile house of cards waiting to be overloaded by heavy spring snows.

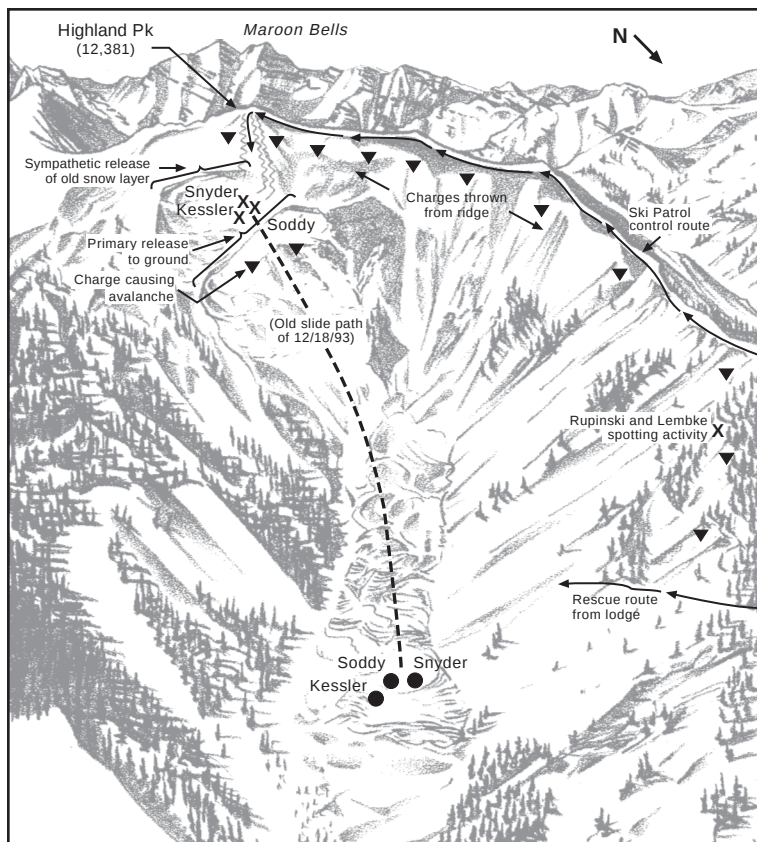
March: In late March the big storm finally hit and smothered the mountains. The San Juans caught the brunt of it with heavy snowfall triggering the season's

only true cycle of large destructive avalanches. In the western San Juans some of the biggest avalanches in memory fell. These wiped out hundreds of acres of timber and destroyed a home near Silverton. Avalanches claimed two additional lives in March. A back-country snowboarder died on Berthoud Pass and an out-of-area skier died near Aspen.

April: A cool, snowy April meant few avalanches due to thaw but continued the prospects for deep releases. In fact two more people died in avalanches: a climber on St. Mary's Glacier and a snowshoer on Berthoud Pass. It would be May before the snowpack started to melt away.

When the numbers were tallied, seasonal snowfall ranged from 87-106 percent of normal, and temperatures were warmer than normal. Observers reported 2,958 avalanches, about 40 percent above average. A record number of people (101) were caught by avalanches. Six people were killed, which is the current average, and property losses were less than \$200,000.

—Dale Atkins



Drawing of avalanche accident at Aspen Highlands, March 31, 1984 from The Snowy Torrents

Engineers, Geologists, Planners, Local Officials, and Builders . . .

GEOLOGIC HAZARDS AND ENGINEERING PRACTICES IN WESTERN COLORADO

Sponsored by Colorado Geological Survey

Thursday, October 29, Friday Morning, October 30, 1998

Hotel Colorado, Glenwood Springs, Colorado

Optional Half-Day Field Trip,

Friday Afternoon,

October 30



Purpose of the Conference

- ◆ To bring together the many stake-holders who are living in, building on, and working within geologic-hazard areas in western Colorado;
- ◆ To clearly define the nature and impact of problems related to geologic hazards in the state;
- ◆ To encourage architects, engineers, geologists, homebuilders, planners, homeowners, and local and state government leaders to learn from each other and find practical, integrated solutions to problems inherent to Colorado's complex geology.

GEOLOGIC HAZARDS AND ENGINEERING PRACTICES IN WESTERN COLORADO

REGISTRATION FORM

Name(s) of participant(s)

Affiliation

Street address

City

State

Zip Code

Mastercard® or Visa® charges

☐ MC

☐ V

Name on card

Card no.

Expiration date Phone No.

Signature

Number of registrations

For conference and Friday field trip _____ x \$150 = \$
(includes Thursday lunch, Friday breakfast & lunch, plus conference packet and fieldtrip guidebook)

For conference only _____ x \$100 = \$
(includes Thursday lunch, Friday breakfast and lunch, plus conference packet.)

Call for student rates.

Names of people attending FIELD TRIP, Friday,
Oct. 30 (12:30–6:30):

Registrations will be taken by phone or FAX but must be paid with VISA or Mastercard or send a check to:

Colorado Geological Survey

1313 Sherman St., Room 715

Denver, CO 80203-2239

(303) 866-2611

FAX (303) 866-2461

CONFERENCE AND FIELD TRIP PROGRAM

OCTOBER 29 SCHEDULE

CHECK IN (7:30–8:30 A.M.)

MORNING SESSION 1 (8:30–10:15 A.M.)
JIM SOULE, MODERATOR

Opening Remarks

Vicki Cowart, Colorado Geological Survey

**Local Government Needs and Problems
in Achieving Smart Growth**

Victoria Giannola, Garfield County Planning

**Geologic Hazards, Land Use Laws and Professional
Standards of Practice**

David Noe, Colorado Geological Survey

**DOLA Technical and Financial Assistance Available to
Local Governments for Smart Growth**

Charles Unseld, Dept. of Local Affairs, Field Services Section

COFFEE BREAK (10:15–10:35 A.M.)

MORNING SESSION 2 (10:35 A.M.–12:00 P.M.)
JIM SOULE, MODERATOR

Programs and Services in Western Colorado
Fred Sibley, Office of Emergency Management

**CGS Multipurpose Geologic Mapping Program
in Western Colorado Growth Areas:
Direct and Spinoff Benefits Derived**
Bob Kirkham, Colorado Geological Survey

**The GIS–Geology Connection—Making the Most of
Multipurpose Digital Geologic Maps**
Randy Phillips, Colorado Geological Survey

LUNCH (12:00–1:00 P.M.)

AFTERNOON SESSION 1 (1:00–3:00 P.M.)
DAVE NOE, MODERATOR

Active Landsliding in Urban(izing) Areas
Mike West, Michael W. West and Assoc., Inc.

**Western Colorado Earthquakes, Seismicity and
Significance to Project Designs**
Ivan Wong, Woodward-Clyde Consultants, Oakland, CA.

**Prediction of Potential Sediment Yields Contributing to
Debris or Hyperconcentrated Flows of Watersheds in
Burned Areas**

*Robert C. Rasely, U.S. Dept. of Agriculture, Natural Resource
Conservation Service, Salt Lake City, UT.*

COFFEE BREAK (3:00–3:20 P.M.)

AFTERNOON SESSION 2 (3:20–5:00 P.M.)
DAVE NOE, MODERATOR

**Geologic and Geomorphic Settings and Identification
of Areas Prone to Collapsing Soil and
Evaporitic Bedrock Hazards**
Jon White, Colorado Geological Survey

**Evaluation, Design and Mitigation of Project Sites
in Collapsible Soil Areas**
Steven Pawlak, Hepworth-Pawlak Geotechnical, Inc.

**Geological Setting and Hazard Evaluation for Evaporite
Sinkholes and Related Underground Voids**
Ralph Mock, Hepworth-Pawlak Geotechnical, Inc.

OCTOBER 30 SCHEDULE

CONTINENTAL BREAKFAST (7:30–8:30 A.M.)

MORNING SESSION (8:30–11:30 A.M.)
MARK BEAN, MODERATOR

**Hydrologic Changes in a Wildfire Burn Area: Buffalo
Creek, Colorado, a Continuing Case Study**
Brian Hyde and Tom Browning, Colo. Water Conservation Board

**ISDS Systems, Site Conditions, Design Options
and Problem Conditions**
Ed Church, E.O. Church, Inc.

**Advantages, Options and Economics of Central
Wastewater Treatment Systems**
John Kaufman, McLaughlin Water Engineers

COFFEE BREAK (10:25–10:45 A.M.)

**Smart Growth Panel with Question and Comment Session
for Feedback from Attendees**
Discussion Leader: *Vicki Cowart*
Panelists: *Marian Smith, Dave Noe, Steve Denney,
Ron McOmber, Erin Johnson, Mike West*

LUNCH (11:30 A.M.–12:30 P.M.)

**(Registered Field Trippers Must be
on Board Buses by 12:35 P.M.!!)**

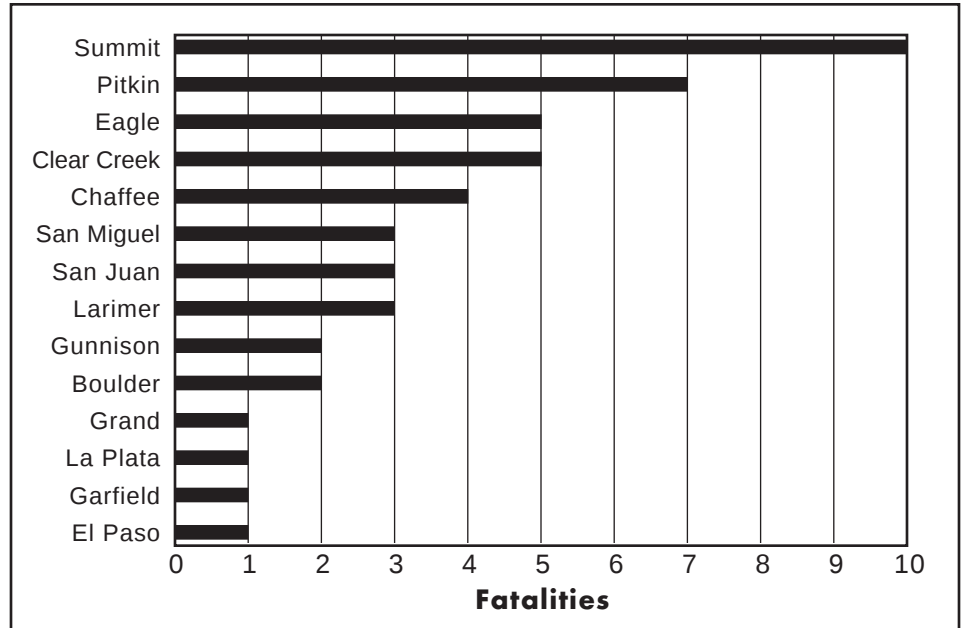
FIELD TRIP (12:30–6:30 P.M.)
**FIELD TRIP LEADERS: JON WHITE, LIV BOWDEN,
RALPH MOCK, BOB KIRKHAM, SUE CANNON**

The field trip will visit sites in Garfield, Eagle, and Pitkin Counties that illustrate special geologic conditions, problems and mitigation options. Discussions at each site will be led by geologists and engineers experienced in identification and mitigation of geologic hazards.

TRENDS IN AVALANCHE ACCIDENTS: GOOD NEWS FOR COLORADO!

All across the U.S., the number of winter sports enthusiasts are soaring, and so are avalanche accidents and deaths. U.S. avalanche deaths have risen 118 percent during the 1990s, so that in an average winter 24 people die in avalanches in the U.S., with six of these deaths occurring in Colorado. Three reasons account for this trend: 1) more people participate in winter sports, 2) better equipment enables enthusiasts to travel in deeper snow and onto steeper slopes, and 3) back-country travelers have increased their acceptance of risk.

Though avalanche deaths in the U.S. have soared the last 10 years, those in Colorado are unchanged (at six a year) even when winter recreation has boomed. Graph 1 shows that in the late 1980s avalanche deaths in Colorado accounted for more than half of all the U.S. avalanche fatalities, but in the 1990s the ratio has dropped to one in four. This drop in number may be partially attributed to greater public avalanche awareness and education.

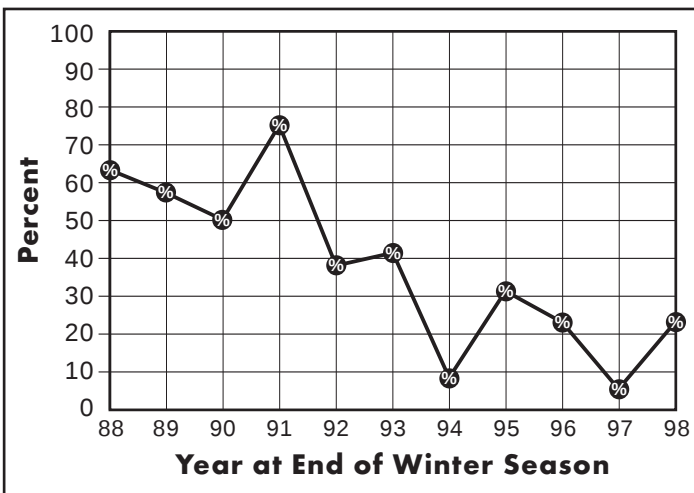


Graph 2: Avalanche fatalities by Colorado County since 1990

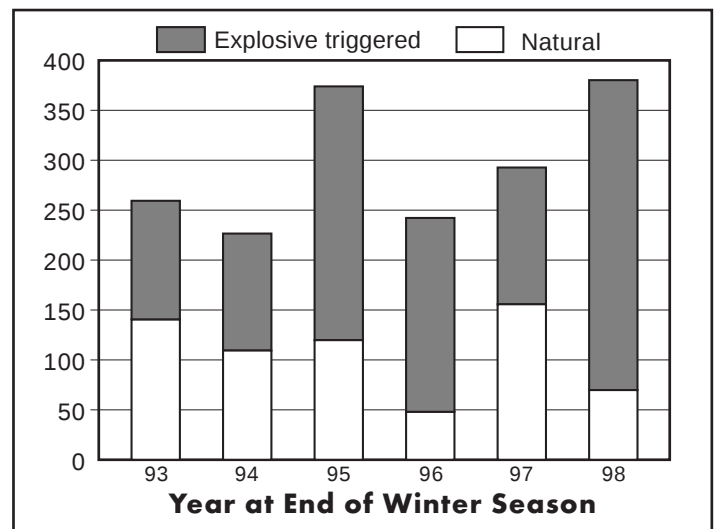
Increasing avalanche awareness is key to saving lives. Since most avalanche victims trigger their own avalanche, this means most accidents are preventable. To increase public avalanche awareness, the Center widely disseminates its daily forecasts and a variety of educational outreach (see "Education Can Save Lives").

Where the Accidents Occur

Let's look at where accidents are happening by county. In Colorado 48 people have died in avalanches since 1990 (Graph 2). It should be no surprise that Colorado's most popular mountain counties head the list. It is important to note that



Graph 1: Colorado avalanche deaths as a percentage of U.S. deaths



Graph 3: Avalanches hitting Colorado highways

all the avalanche deaths have occurred in the back-country or beyond ski area boundaries (because the back-country snow-pack gets no stabilizing effect from explosive control or skier compaction).

Impact of Avalanches on Colorado's Highways

Colorado has the most avalanche-prone highway system in the U.S.. A total of 19 different state and federal highways are affected by avalanches; the total is significantly greater when numerous county roads are included. Graph 3 shows the number of natural and purposely triggered avalanches hitting mountain highways the last six years. Since 1992 an average of 115 avalanches release naturally onto Colorado highways. And to safeguard our highways, CDOT uses explosive control to release an average of 179 additional avalanches each winter. By triggering more frequent but smaller avalanches, safety is increased and



Avalanche debris blocking highway

delays are reduced. The program works: the last avalanche death of a motorist occurred back in 1963.

As Colorado's population grows dramatically in the coming years, so too will winter use and the potential for more avalanche

accidents and deaths. If the best defense is a good offense, the CAIC's forecasting and education program is well prepared to reduce the impact of avalanches upon the people who work and play in Colorado. —Dale Atkins

CGS MISSION STATEMENT

The CGS mission is to serve and inform the people of Colorado by providing sound geologic information and evaluation and to educate the public about the important role of earth sciences in everyday life in Colorado.



ROCK TALK

Colorado Geological Survey
1313 Sherman Street, Room 715
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