Snow Avalanches

Basic Principles for Avoiding and Surviving Snow Avalanches

By Lance Young

Introduction

Snow avalanches are complex natural phenomena, experts do not fully understand all their causes. No one can predict avalanche occurrences with certainty, but we know that avalanches can have tremendous force and can be life threatening to winter travelers.

The more time you spend skiing, snowboarding, snowshoeing, snowmobiling, and enjoying other winter activities, the greater your chances are of being caught in an avalanche

Knowledge can help you avoid being caught in an avalanche; it may also help you survive if you are buried. The general guidelines in this presentation will help the thoughtful person develop good judgment about the presence and degree of avalanche danger play it safe check the avalanche hazard forecast for the area in which you plan to travel think about the changing weather, terrain and snowpack conditions around you and constantly update your assessment of the avalanche hazard!

Snow Avalanches

Avalanches are caused by unstable snow. Snow that is not well bonded to a hillside, underlying snow layers or other snow crystals, is considered unstable snow. Weather, terrain, and the snowpack influence the potential for avalanches.

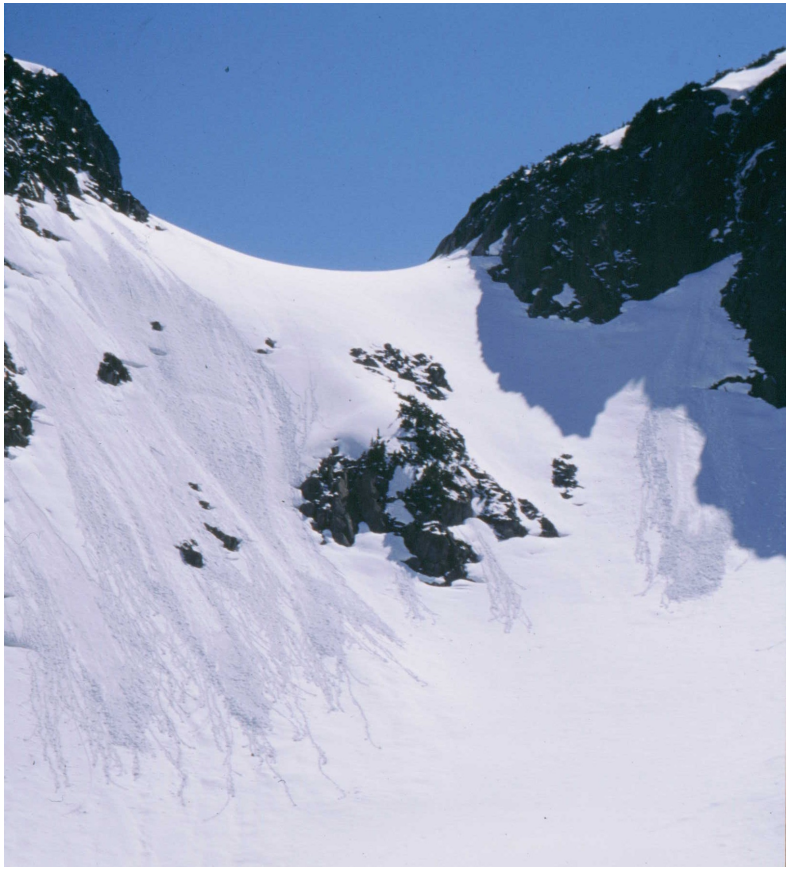
Loose snow slough avalanches, start when unattached snow crystals slide down a slope these avalanches grow in size as they descend forming and inverted V.

Slab avalanches, on the other hand start when a solid area of snow breaks away at once. There is a well defined fracture line where the moving snow breaks away from the stable snow.

Most people who are caught in avalanches, trigger the avalanche that catches them. Their weight on the stressed snow is often enough to break the fragile bonds that hold it to the slope or other snow layers, this weight and its effect on the snow may be intensified by a fall or by machines such as snowmobiles.

Loose Snow Slough Avalanches

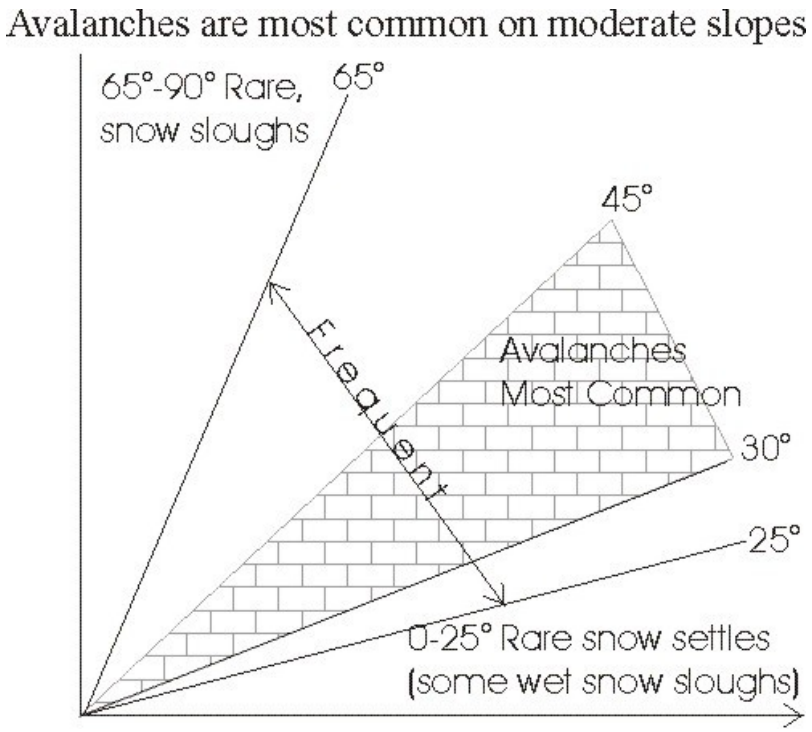
- A **slough** starts at a single point and spreads from there as more surface snow is entrained from the sides of the slide.



Slab Avalanche

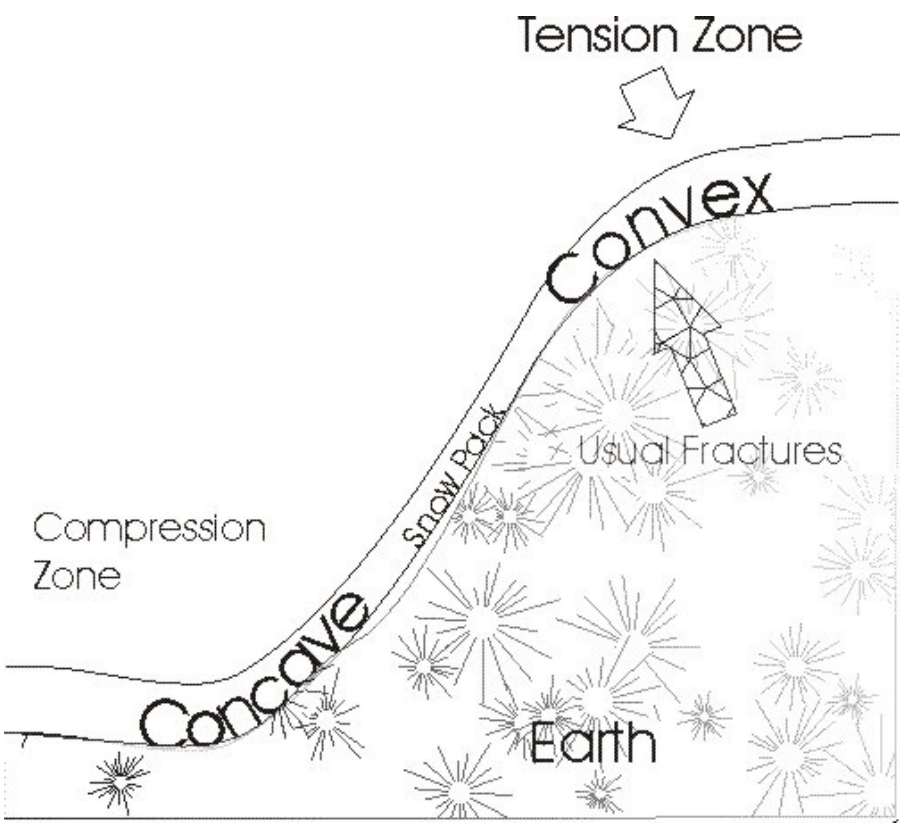
- A slab can be a hard slab (wind packed), or soft slab (new snow) but starts all at once with a fracture running across the hill at the crown or start point then the whole slope starts to move as one.

Terrain Factors



- Slope steepness – Avalanches most frequently occur on slopes of 30 to 45 degrees, but they may release from 25 to 65 degree slopes. The diagram illustrates the slope angles where avalanches most commonly occur.

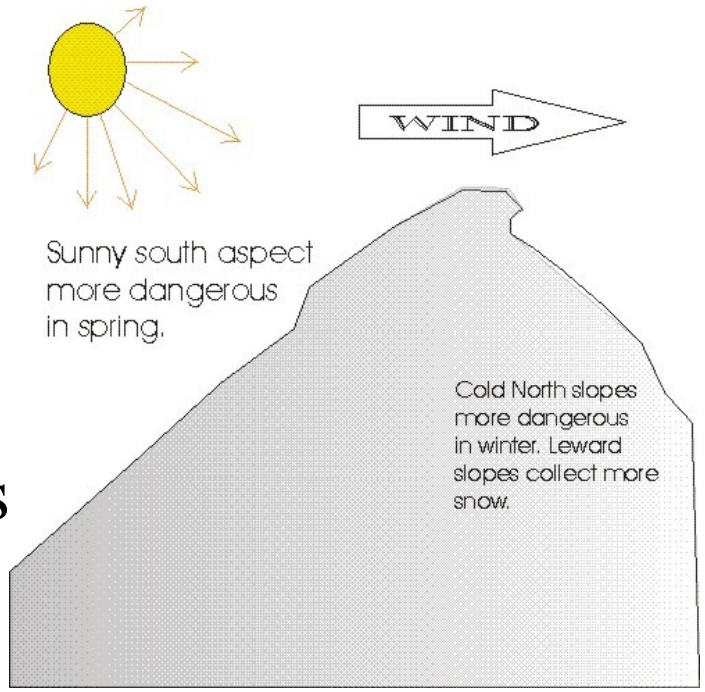
Slope Profile



- Slope profile – Dangerous slam avalanches are more likely to begin on convex slopes but may also begin on concave slopes. Short slopes may be as dangerous as long slopes, especially if an avalanche carries its victims over a cliff or into a valley, trees, rocks, or crevasses. Forty-two percent of all avalanche fatalities result from slides running less than 300 feet (91 m.).

Slope Aspect

- North facing slopes may be slower to stabilize then slopes facing in other directions, south facing slopes are especially dangerous in the spring when heated by the sun. Leeward slopes, the side away from the wind are dangerous because this is where the snow collects and may form an unstable slab. Windward slopes, the side facing the wind generally have less snow, and are usually more stable.



Snow Cover Factors

- Snow Depth and Anchoring

- Large rocks, trees, and heavy brush help anchor the snow. Smooth, opened slopes without these natural anchors are more dangerous. But avalanches can start even among trees. When the snow depth is sufficient to cover natural anchors, additional snow layers will slide more readily

- Snow Layering

- Old Snow Surface Condition

-

- Snow depth –

- Snow layering – Make a habit of testing the layering and bonding of the snow structure by using ski or probe poles. Feel how the strength of the various snow layers changes as you push your probe through the snowpack. Do these relative layering tests often as you move from area to area, remembering that the snow structure and its stability can change significantly from slope to slope. Pay particular attention to very weak or very strong layers buried beneath the surface snow. The strong layers may act as a sliding surface for avalanches, especially if overlaid by a weak layer. If you are uncomfortable about what you feel (such as heavy snow over light snow), conduct further stability tests such as ski cutting, snow pits, or Rutschblock tests to verify the condition.

- Old snow surface –

- Snow depth –
- Snow layering –.
- Old snow surface – It is important to know the condition of the old Snow surface when trying to assess developing snow stability. For example, cold snow falling on hard frozen snow surfaces, such as sun or rain crust, may form a week bond and lead to a rapid hazard increase.

Weather Factors

1. Changing factors – wind, rain, snow,
2. Winds – 15 mph or more
3. Temperature – cold in winter, warm in spring
4. Storms –
5. Rate of snowfall – one inch per hour
6. New snow – one foot or more total accumulation
7. Wet snow – warm winds or rain

Weather Factors

1. Changing factors – Rapid changes in the weather conditions (wind, temperature, snow, rainfall) cause changes in the stability of the snowpack; therefore, be alert to weather changes. Snowpack changes may adversely affect the cohesiveness of the layers of snow or the forces on weak layers, thereby increasing the likelihood of an avalanche.

Weather Factors

2. Winds – Sustained winds of 15 miles per hour or more even during clear whether, may increase danger rapidly since such winds can quickly redistribute large amounts of loose surface snow.

Snow plumes from ridges and peaks indicate that snow is being moved onto leeward slopes, which can accumulate 10 times as much windblown snow as nearby valley locations. This can create dangerous wind slab conditions on Lee slopes.

Weather Factors

3. Temperature – Cold temperatures tend to maintain an unstable snowpack, while warm temperatures (near or above freezing) allow snow to settle or strengthen more quickly, thus making the snowpack more uniform and stable.

4. Storms – A high percentage of all avalanches occur during, or shortly after storms.

5. Rate of snowfall – Snow falling at the rate of one inch per hour or more increases avalanche danger rapidly.

6. New snow – Be alert to dangerous conditions with a foot or more of new snow. Remember that new snow depth may vary considerably with slope elevations and aspect over short distances.

Weather Factors

7.wet snow – A rainfall can rapidly weaken surface snow and overload., weak layers, sometimes causing avalanches to occur almost instantaneously with the start of rain. Rain may also percolate through the snow until it reaches an ice layer. It can then lubricated the ice layer and produce large, wet slab avalanches. During sustained rainfall a series of avalanches may occur on the same slope as progressively deeper snow layers are weakened and stressed.

Wet slab avalanches are also produced in the spring rain by strong sunlight radiating through clouds thereby melting and weakening the snow cover when followed by clouds overnight which prevent the snow from refreezing, dangerous avalanche conditions may develop the next day when temperatures increase

General Observations

1. Old slide paths

3. Recent avalanche activity

5. Sounds and cracks

7. Elevation

9. Volcanic peaks

11. Information

General Observations

1. Old slide pads – Generally, avalanches reoccur in paths where they've occurred before. Look for pushed over small trees and trees with limbs broken off. Avoid steep gullies and open slopes.
2. Recent avalanche activity – If you see evidence of recent avalanche's suspect dangerous conditions especially on other slopes with similar aspects.
3. Sounds and cracks – If the snow sounds hollow, particularly on a leeward slope, conditions are probably dangerous. If the snow cracks and the cracks spread, this usually indicates slab avalanche danger is high.

General Observations

4. Elevation – Although avalanche danger generally increases with elevation, unusual weather conditions combined with local topography may occasionally reverse this relationship.
5. Volcanic peaks – On volcanic peaks above 8000 to 10,000 feet elevation, significant avalanche hazard may exist during any time of year.
6. Information – Check the local weather and avalanche forecasts. Generally, NOAA weather radio will carry these forecasts when high or extreme hazard is expected. You can also contact the forest service or nearest ski area.

Stability Tests

<u>These tests must be performed on or near the slope you are going to cross</u>

3. Shovel test
4. Snow Pit
5. Rutschblock test
6. Explosive test: (professionals only)

Stability Tests

1. Shovel test: This test is good for evaluating near surface instabilities. First excavate a small pit, then insert the blade of your shovel in the undisturbed snow above the pit. Insert blade to the depth of the suspect sheer layer and pull it toward you to see if the snow separated at the suspect layer
2. Snow pit test: This is a method for studying the densities and makeup of the snow pack by excavating a pit frequently to the ground level and looking at the layering. This evaluation is beyond the scope of this presentation

Stability Tests

Rutschblock test: is usually used to test slopes prior to skiing them. It produces an approximate scale of risk and works as follows:

RUTSCHBLOCK QUICK REFERENCE

Reminders:

•Excavate with shovel the sides and down slope leaving an up slope connected 1.5 m.down x 2 meter across snow block (rutschblock)

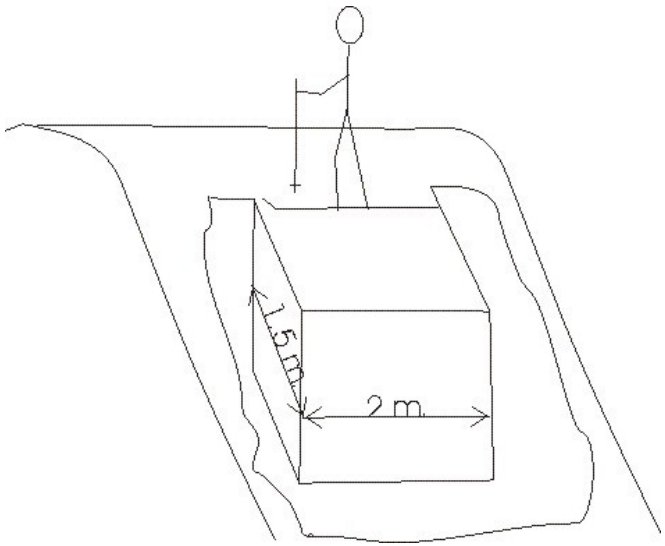
•Must be done on a slope which is representative in slope angle as well as snow pack yet safe enough to perform the test.

•Only tests layers deeper than ski penetration & Shallower than the pit excavation

•Test more effective for slopes > 30 deg.

•Can take some time and effort to do properly.

•Never base your decisions on only one piece Of data, even a rutschblock score!



This card is intended only as a reference, it is not instructional. To learn how to do a proper Rutschblock test and also how to put it into context take an avalanche safety course.

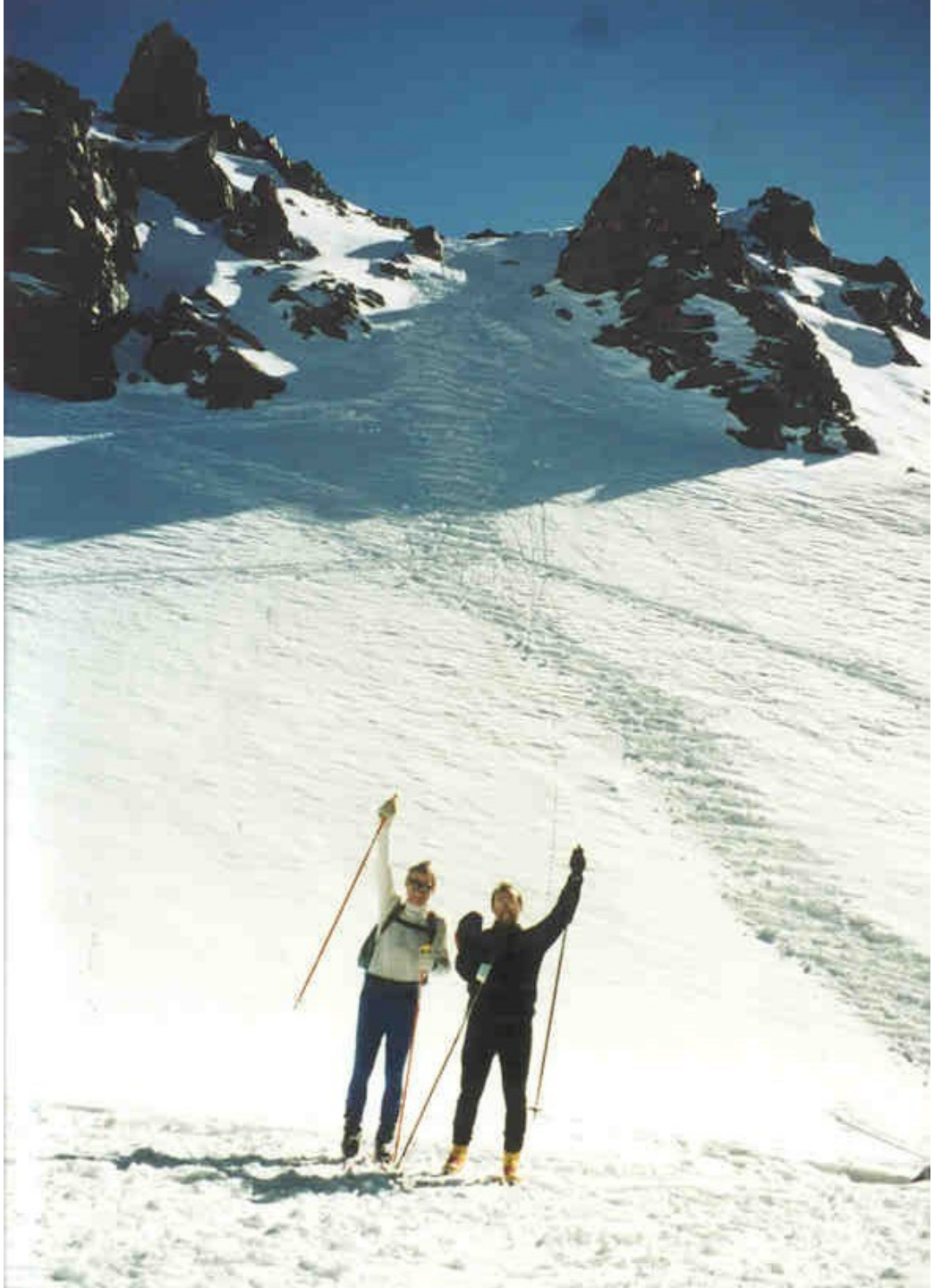
Score	Loading Block Produces a Clean Shear
1. {red}	During Digging or Cutting the up slope connection
2.	While approaching or stepping onto block (within 35 cm of top)
3.	Knee bend (pushing with knee bend-no jump)
4. {yellow}	One Jump
5.	Second Jump
6. {green}	Multiple jumps, or jump on block without skis
7.	Does not fail

Interpretation:

Red: Slope is unstable, skier triggering of similar slopes is probable

Yellow: Stability is suspect, skier triggering of similar slopes is possible. Collect additional information and use caution.

Green: Stability should be good. Remember that stability can vary over short distances, and safety measures are always appropriate.



Avalanche Hazards Ratings

- **Low** avalanche hazard – Mostly stable snow exists, and avalanches are unlikely except in isolated pockets on steep, snow-covered, open slopes and gullies. Backcountry travel is generally safe.
- **Moderate** avalanche hazard – Areas of unstable snow exist, and avalanches are possible on steep snow-covered, open slopes and gullies. Backcountry travelers should use caution
- **High** avalanche hazard – Mostly unstable snow exists, and avalanches are likely on steep snow-covered slopes and gullies. Backcountry travel is not advised
- **Extreme** avalanche hazard – Widespread areas of unstable snow exists and avalanches are certain on steep, snow covered, open slopes and gullies. Large destructive avalanches are possible. Backcountry travel should be avoided.

No matter what the avalanche hazard, there are avalanche free areas in the mountains.

Route Selection and Precautions

The safest routes are on ridge tops and slightly on the windward side away from cornices. Windward slopes are usually safer than leeward slopes. If you cannot travel on ridge is, the next safest route is out in the valley far from the bottom of slopes.

Avoid cornices move toward ridge tops by detouring around cornice areas. If you must cross a potentially dangerous slope stay high and near the top. If you see cracks or avalanche fracture lines in the snow, avoid them and nearby similar slopes

Only one person at a time should cross a potentially dangerous slope. All others should watch. Before crossing the slope, remove ski pole straps, ski safety straps, and loosen all equipment so they may be discarded should a slide be triggered. Fasten all clothes, put on hat and gloves and raise your parka hood. Each person in the party should carry and know how to use, avalanche transceiver, sectional probe pools, and a shovel.

If you must ascend or descend a dangerous slope: go straight up or straight down; do not traverse back and forth across the slope. Take advantage of areas of dense timber ridges, or rocky outcroppings as islands of safety. Use them for lunch and rest stops. Spend as little time as possible on open slopes. As the hazard increases, route selection becomes more important

Route Selection

Avalanche Survival

If you are caught in an avalanche – Discard all equipment and move away from a snowmobile if you're riding one.make swimming motions. Try to stay on top; work your way to the side of the avalanche. Before coming to a stop get your hands in front of your face and try to make an airspace in the snow. If you know you are close to the surface, try to stick a hand or foot out of the snow so you can be easily found. Try to remain calm!

If you see someone caught in an avalanche – Mark the location where you last saw the victim. Search directly down slope, below where the victim was last seen. If they are not on the surface, scuff or probe the snow with a ski pole or probe pole or use avalanche transceivers if the victim is wearing one.

Avalanche Survival

You are the victims best hope of survival– Do not desert the victim by going for help, unless help is only a few minutes away. Remember, you must consider not only the time required for you to get help but the time required for help to return.

First aid – Treat for suffocation, shock, impact injuries and hypothermia.

Time is the key to survival – After ½ hour, the buried victim has only a 50 percent chance of survival.

Avalanche safety is an integral part of winter recreation in the mountains. With a little training, some practice and proper precautions winter can be a safe, serene, and truly remarkable season in the mountains.

The End

This presentation was produced by Lance Young and is based on information provided by the US Department of Agriculture. In dedication to the memory of

Dr. Ron Gregg

<u>Further Information is available:</u>

5. The Avalanche Handbook by McClung and Schaerer
6. Avalanche Safety for Skiers and Climbers by Daffern
7. Snow Torrents III by Williams
8. ABC of Avalanche Safety by LaChapell
9. Snow Sense by Fesler and Fredston
10. The Avalanche Book by Williams and Armstrong
11. Video-Avalanche Awareness
12. Video-Winning the Avalanche Game