# <u>Differential Heat Transfer--It's Effects on Avalanche Release in the Mountain Snowpack</u>

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## Abstract

Certain correlations are observed when examining recent avalanche accidents in Colorado. An examination into six backcountry incidents reveals the presence of a metamorphic principle common to each in the trigger area. The number of avalanche accidents involving winter backcountry travellers can be reduced through education regarding this basic factor, and encouraging the practice of related routefinding techniques.


For the purposes of this paper, only dry slab avalanches typical to the realm of a high elevation, continental climate zone are addressed.

## Introduction

For many years there has been a premise that when crossing a potential avalanche path, one should plan his route so it takes him from one "island of safety" to another until reaching protection on the far side of the path. These "islands of safety" have been described as being tree groups or rock outcrops.

This may be valid in certain situations. To be effective, the "safety" concept needs to meet specific criteria: The tree island or terrain feature in question must be of substantial size to divert the moving snow around a person should an avalanche occur. If, however, this barrier is not of sufficient proportion in respect to the dimensions of the avalanche starting zone and its snow-holding capacity, then the effectiveness of that barrier is significantly reduced.

Based on what is currently known about the characteristics and behavior of snow, a question must be raised about the validity of the philosophy in general. Could it be that these "islands of safety", regardless of size, are in fact regions of inherent snowpack frailty harboring even <u>greater</u> potential for an avalanche to be triggered here by the unweary backcountry traveller? The answer is yes.

It has been shown that areas of weakness and stress concentration are found around terrain and vegetation features that protrude into and through the snowpack. There are many examples of fracture line propagation from rock-to-rock, rock-to-tree, etc. In other words, the paths of slab tension failure are transmitted from *weak point* to *weak point* by the sudden release of stress built up due to gravity.

If this is indeed the case, then choosing a route that takes you several meters one way or another could make the difference between precipitating an avalanche and not. Later we will exmine six avalanche accidents, each having a common element that indicates similar release mechanisms, and all involving differential heat transfer through the snowpack.

The total concept can also be applied to avalanche management techniques through the use of explosives. Snow safety workers using hand-thrown charges, an avalauncher or artillery often get better results (controlled avalanches) by shot placement in weaker areas of the snowpack where there is greater stress concentration.

Differential Heat Transfer

The results from measuring the temperature difference from the snow/ground interface to the snow surface, or in spatial intervals within the snowpack, will indicate to the type of metamorphism taking place. A common technique when teaching about snow temperature gradients is to use the example of a cross-section of snow resting on a flat plane, and taking readings every so many centimeters vertically through the snowpack. This is fine for demonstration purposes, but we need to go a step further to be more realistic about the natural setting of actual conditions.

Obviously, the snowpack is not of uniform depth from one area to another. Terrain configurations and wind deposition or erosion can alter snowcover thickness significantly over short distances. This, in turn, changes temperature patterns in the snowpack. The end result is the influence on the type of metamorphism taking place at a particular location (ET or TG). The "strength" of the temperature gradient is also influenced.

On sun exposed terrain where rock outcrops or vegetation protrudes through the snow, additional heat is transfered into the snowpack from the solar radiation heat gain of the object. In this case temperature gradients not only exist from the ground to the surface, but laterally into the snowpack as well. A strong gradient now persists close to the surface of the snow. In many instances, geothermal heat is transfered into the snow from all surfaces of the terrain feature. TG grains or even "melt-back" (hollow spaces) can be found when excavating snowpits around rocks.

From direct field observations we know this to be true. Weaker snow structure, in the form of angular, faceted grains, can be found in different stages of development around terrain and vegetation features. We also know these locations to be areas of greater stress consentration.

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This paper is meant as a accessory handout to the topic of "Trigger Zone Temperature Patterns in the Snowpack" presented at the SCPAC February 12-13, 1990. It is not conclusive in itself, but offers supplemental information on the subject introduced.