

# Avalanches and Microstructure

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At the most basic level, the ingredients for a snow avalanche are, quite simply, snow on a slope. However, there is clearly more involved, since these are also the ingredients essential for downhill skiing. Two events that are best kept separate! Snowflakes accumulate on the ground to form a granular ice structure, which is in constant transformation. Environmental conditions may dictate that the grains develop into generally rounded shape with ample bonding; or under different circumstances new faceted crystals may develop that are indicative of snow with a low structural integrity. Snow on the ground may strengthen or weaken; in fact both processes may occur simultaneously within the snowpack. It is the microstructural arrangement that ultimately determines instability and the scale of an avalanche. The sensitivity of the snow to environmental conditions causes a seasonal snowpack to develop a layered stratigraphy, where both the intergranular and interlayer strength is essential to determining the avalanche potential. It is also important to consider that the transfer of a trigger force, such as a skier or an explosive, to a weak layer is influenced by the mechanical properties of the overlaying snow. Weak layers that develop while at the snow surface may become problematic when subsequently buried, providing a fragile layer that cannot support the overburden of subsequent snowfalls or triggers. Alternately, layers near the ground may weaken over time, resulting in full depth avalanches. An understanding of the energy interaction between the snow and the environment is necessary to determine the likely metamorphism. Despite the dramatic, sometimes large scale destructive nature of avalanches, it is an assessment of the microstructure of the snowpack which is a key component to forecasting.



Ed Adams is a Professor of Engineering Mechanics at Montana State University. His research is in the area of snow and ice with a particular focus on avalanche phenomena. His fascination with avalanches initially developed as a prerequisite for safe backcountry skiing. Specifically his research includes snow metamorphism, avalanche dynamics. Additionally, he has conducted research into thermal processes involved in highway icing and chemical anti-icing, and describing the physical habitat necessary for sustaining microbial life within Antarctic ice.

In addition to seasonal field research in the mountain west and midwest he has spent five seasons conducting field research in the Antarctic. Currently, he is the Director of the newly developed Sub Zero Science and Engineering Research Facility. This facility features a suite of low temperature laboratories geared toward multidisciplinary research focused on the cold environment.

He has worked at the Shinjo Branch of Snow and Ice Studies of the Japanese National Research Institute for Earth Science and Disaster Prevention, as an invited scientific specialist and with the WSL Swiss Institute for Snow and Avalanche Research, SLF in Davos. As outreach, his research have been featured in National Geographic Explorer, National Geographic Extreme Explorer, National Geographic Adventure People Magazine, New York Times – Science Times, the Discovery Channel, the History Channel, Discovery Channel Canada , with live appearances on Good Morning America, CNN's AC 360, World News Tonight, on various regional and national news casts, featured in an upcoming exhibit at the Museum of Science And Industry in Chicago.