Clear Skies Does Not Always Equal Clear Sailing

A Look At The Formation Of Persistent Weak Layers

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The snowpack is a record of weather events that take place during the winter. Heavy snows, wind, even long dry spells, help to create unique layers in the snowpack. The order in which these weather events occur determines both the structure and stability of the pack.

The layers that tend to cause the most avalanche problems throughout the winter generally form between storms. Known as persistent weak layers, there are three main types that form in southwestern Montana - depth hoar, surface hoar and near surface facets. Each of these is capable of existing in the snowpack for long periods of time and can produce avalanches weeks - or even months - after a storm.

A weak layer is one of the four ingredients required to create an avalanche- the other factors being slope angle capable of sliding, a slab of snow and a trigger. It may seem counter-intuitive, but weak layers are often created during dry spells - it is important to pay attention to changing structure in the snowpack, even when there is no new snow.

The main process that drives the formation of persistent weak layers is strong temperature gradients. Gradients are essentially the difference in temperature over a distance - in this case the difference in temperature between the ground which is at a constant 32 F during the winter and the air temperature which varies daily. Temperature gradients are responsible for the formation of facets in the buried layers of the snowpack.

Shallow snowpacks often fall victim to large temperature gradients - sparking the formation of weak, sugary snow near the ground known as depth hoar. Depth hoar forms when there has been a storm or two, providing a shallow snowpack,that is exposed to a cold and clear weather pattern. If a cold clear pattern persists, faceted grains will form and can become cup shaped, reaching 4-10 mm in size. These grains have a hard time sticking together due to their angled structure and large crystal size. Typically, the larger the grain size the more persistent the instability. Depth hoar layers easily can become preserved deep in the snowpack and create instability for weeks or even months.

As the snowpack becomes deeper throughout the season, temperature fluctuations mostly impact only the top 15-20 cm of the snow surface. The longer the surface is exposed to large day and night temperature swings, the weaker the snow surface will become. This process is called diurnal recrystalization and creates small angular grains known as near-surface facets. These faceted layers can become buried by subsequent storms and linger for extended periods of time. In southwest Montana, nearly 60% of all human triggered slides occur on near-surface facet layers (Birkeland, 1996).

A less common but equally dangerous persistent weak layer is surface hoar. This layer is the dew of winter, featuring large feathery crystals that form during cold, clear and calm nights. Due to the fragile nature of surface hoar crystals, they are easily destroyed by direct sun or wind. But patchy areas of surface hoar can survive weather events. Once buried, sporadic distribution can make this layer both unpredictable and hazardous. Buried layers of surface hoar are renowned for fracturing far and wide and can create avalanches that are capable of propagating into low-angle terrain.

The next time Montana's under a spell of high pressure, look closely at the snow surface. Future weak layers are likely forming.