No Snow, Big Problem

By Doug Chabot

It hadn't snowed in days. I was out skiing and digging snowpits, testing the stability. Layers were bonding to one another and I couldn't find any trouble in the snowpack. But I wasn't happy. In the avalanche world more snow usually equals more avalanches, but days without snow can create problems too. During times of sunny weather the snowpack does not remain static. I was seeing this firsthand as the snow surface got weaker by the day. Unburied, this layer is insignificant, yet once covered it has the power to create avalanches.

Instead of falling from the sky, many weak layers form at the surface, sometimes days after a snowstorm. Variables such as air temperature, snow temperature and sky cover can drive snow metamorphism and begin to weaken the surface. Snow exposed to clear skies, nighttime temperatures in the single digits followed by warming days reaching the 20s, will begin to weaken immediately. This metamorphism occurs when daily temperature fluctuations create steep temperature differences in the top few inches of the snowpack. During the day the snow gets hit with lots of sun and warmth (shortwave radiation) that only penetrates the upper few inches. At night the snow surface cools sharply, more so than the air, especially when clear skies allow unimpeded longwave radiation loss. Clear skies make the air and snow surface colder while clouds act as a blanket.

Driven by these steep and oscillating temperature gradients, water vapor migrates from snowflake to snowflake, and snow crystals rearrange their structure into small, angular, faceted grains. These do not bond well to future snows. Consecutive cold nights and relatively warmer days churn out the facets fast. The longer the surface is exposed to daily temperature swings the further into the snowpack these sugary crystals form. The technical term for these crystal types is *near-surface facets*, but skiers know it as recycled powder. It's like magic—powder-like turns even though it hasn't snowed. What is not so magical is how this recycled surface becomes a nasty, scary layer once it's buried. The crystal's sharp edges don't adhere to each other or the new snow that falls on top of it. It can be preserved for many weeks, slow to strengthen and prone to avalanche.

Surface hoar, those frozen feathers of snow that miraculously form during the night, are frozen dew. Clear, cold nights with enough humidity and a touch of air movement cause these feathers to sprout like weeds on the snow surface. Many are thumbnail or larger in size and grow largest near creeks where the air is saturated. They are as fragile as fine china and easily melt or get blown over. Although beautiful on the surface the lightest snowfall seals them intact. Strong in compression but weak in shear they are analogous to acres of dominoes. Surface hoar can hold up a great deal of weight and support weeks of snowstorms before breaking, but once they do - look out. They characteristically fracture far and wide, creating avalanches that are known to pull out lower-angled terrain. Ski patrollers and avalanche forecasters all treat buried surface hoar with respect and fear since it surprises even the most experienced.

A weak layer is one of four ingredients in an avalanche. The other three are a steep slope, a slab of snow sitting atop the weakness and a trigger. Here in southwest Montana surface hoar and near-surface facets are responsible for 60% of the weak layers identified in avalanches (Birkeland, 1996). To predict avalanches we spend a lot of time during storms measuring snowfall, its weight, and wind-loading patterns. During dry spells we're busy hunting for the next weak layer to be buried: facets growing at and near the surface. Armed with a crystal card and hand lens we can watch the crystals change daily, sometimes hourly.

The next time Montana's under a bell of high pressure without a cloud in sight look closely at the snow surface. Future weak layers are likely forming.