

## **Changes in the shear strength and micro-penetration hardness of a buried surface hoar layer**

K. Birkeland<sup>1,2</sup>, K. Kronholm<sup>3</sup>, M. Schneebeli<sup>3</sup>, C. Pielmeier<sup>3</sup>

<sup>1</sup>*U.S.D.A. Forest Service National Avalanche Center, P.O. Box 130, Bozeman, MT 59771 USA*

<sup>2</sup>*Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717 USA*

<sup>3</sup>*WSL Swiss Fed. Inst. for Snow and Avalanche Research, Flüelastrasse 11, Davos Dorf, Switzerland*

**ABSTRACT.** We investigated a buried surface hoar layer using the SnowMicroPen (SMP), an instrument designed to measure detailed snowpack profiles. We collected data from two adjacent parts of a slope six days apart. In addition, one manual snowpack profile was sampled each day, as well as 50 Quantified Loaded Column Tests (QLCTs) which provided an index of shear strength. For the SMP data, a 900 m<sup>2</sup> area was sampled on both days in a grid with points 3 m apart, with some sub-areas of more closely spaced measurements. We collected 86 SMP profiles on the first day and 129 SMP profiles on the second day. Our analyses involved manually locating layer boundaries and calculating statistics for the force signal through the surface hoar layer. The shear strength index increased by 40% between the two sampling days, but the SMP data show no statistical difference in layer thickness, and the mean, minimum, median, and a variety of percentile measures of the SMP force signal through the layer also do not change. Interestingly, the maximum hardness, and the variance and coefficient of variation of the SMP signal, increased. Since the small SMP tip might only break one or a couple bonds as it passes through the weak layer, we interpret these changes as being indicative of increasing bond strength. Though we cannot specifically tie the increasing maximum hardness of the SMP signal to our QLCT results, our work suggests that the maximum SMP signal within buried surface hoar layers may be useful for tracking increases in the shear strength of those layers.