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Pilot study on tracing the rapidly buried rock avalanche deposits within the accumulation zone of glacier

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Recent studies shown that large mass failure events significantly contribute to the glacial sediment budget and affect its final deposition. However, in accumulation zone these events are exceptionally fast subsumed by snowfall and become ingested into the glacier with no evident surface expression. This leads to poor understanding of the magnitude-frequency of these events and their contribution to the sediment budget of the glaciers. The buried rock avalanches travel as englacial load within the ice that becomes the unique geomorphic horizon, which may constitute a major fraction of total glacial debris supplied to supraglacial cover of many debris-covered glaciers, but usually re-emerging in ablation zones not in a form usable to reconstruct the magnitude-frequency of these events. Here we present a first attempt to detect the rock avalanche deposit within the ice that becomes the unique geomorphic horizon or isochrones.

Ground Penetrating Radar (GPR) was applied over the large deposit of well documented in January 2013 Mt. Haast/Dixon rock avalanche in Southern Alps of New Zealand, one year after emplacement. The large deposit 2 x 106 m3 of rock, snow and ice travelled 2.9 km over the northern margins of the Grand Plateau, just 200 m west of Plateau Hut, stalling close to the top of the Hochstetter Icefall, Aoraki/ Mt. Cook. The large deposit was lost to conventional remote sensing within 3 month after the event. In April 2014, at the time of the survey the deposit was entirely buried beneath the snow/firn cover, leaving no topographic expression of the deposit at the snow surface. The buried deposit was visible in crevasses, in the Hochstetter Ice Fall, in the Grand Plateau, and the icefall beneath Mt Haast, at depths estimated to be in the order of 5-10 m. Our subsurface data shows a good preservation of a rock avalanche deposit under about 3-5 m of snow and firn with the thickness broadly consistent along the length of the transect (1-2 m), with a thicker (5-7 m) $\sim$170 m wide region at the south-east end of the profile. We show that GPR can be used to measure the burial depth and thickness, characterise the surface morphology, and englacial dispersion of rock-avalanche deposits. These data are essential for establishing event frequency and for contributing to insight into the interaction between large rock avalanches and glacier dynamics, glacial sediment budget and landslide contribution to relief denudation.