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Field experiments to assess the effect of lithology and grain size on the ablation of debris covered glaciers

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Currently many glaciers all over the world show negative mass balances. Because of the retreating ice masses, there is an increase of deglaciated slopes. In combination with increased melting of permafrost these areas can become unstable and account for an additional supply of weathered bedrock and sediments onto the glacier surface. Furthermore increasing ablation rates advance the melting out and accumulation of englacial till on the glacier surface. The experiment was performed during summer season 2010 at the middle tongue of Vernagtferner, a temperate glacier in the Oetztal Alps, Austria. The experimental setup was designed in a way to monitor the parameters which are most crucial for controlling sub-debris ice melt with regards to lithology, grain size and moisture content. Ten test plots were established with different debris grain sizes and debris thicknesses consisting of sieved natural material. The local metamorphic mica schist and volcanic debris were used for the experiment. Ablation was measured at stakes. Bare ice melt was observed continuously with a sonic ranger. Three automatic weather stations were installed to record meteorological data. To obtain information concerning the internal temperature distribution of the debris cover, thermistors were installed at various depths. For each individual plot thermal conductivity and thermal diffusivity have been estimated. The observations during the season revealed a clear dependence of the sub-debris ice melt on the layer thickness and the grain size. For the fine sand fraction the moisture content plays an important role, as these test fields were always water saturated. Highly porous volcanic material protects the ice much more effectively from melting than similar layer thicknesses of the local mica schist. Also the albedo plays an important role, where melt rates under dark debris are about 1.75 times higher than underneath brighter material. The analysis of thermal diffusivities indicates that lower values can be found in proximity to the debris/ice interface. Based on our experiences it can be concluded that test sites need intensive care in order to obtain representative data.