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Investigating the Microscopic Location of Trace Elements in High-Alpine Glacier Ice

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Past changes in atmospheric pollution can be reconstructed from high-alpine ice core trace element records (Schwikowski et al., 2004). Percolation of meltwater alters the information originally stored in these environmental archives. Eichler et al. (2001) suggested that the preservation of major ions with respect to meltwater percolation depends on their location in the crystal ice lattice, i.e. grain boundaries versus grain interiors. Other studies have also focused on the effect of meltwater on organic pollutant concentrations as well as on stable isotope profiles in ice cores, whereas no information exists about trace elements.

Here, we investigate for the first time the effect of the microscopic location of anthropogenic, dust and volcanic related trace elements on the behavior during meltwater percolation by using two different approaches. On the one hand we assess the microscopic location of trace elements indirectly by analyzing trace element concentrations in a high-alpine ice core, which has been shown to be affected by an inflow of meltwater, using discrete inductively coupled plasma mass spectrometry (ICP-MS). Impurities located at grain boundaries are prone to be removed by meltwater and tend to be depleted in the affected section of the record whereas those incorporated into the ice interior are preserved and not disturbed in the record. In the second approach we work towards a direct quantification of differences in concentrations of trace elements between ice grain boundaries and grain interiors in samples both from unaffected and affected sections of this ice core. Therefore we use cryocell laser ablation (LA) ICP-MS, which is the method of choice for the direct in situ chemical analysis of trace elements at a sub-millimeter resolution in glacier ice (Reinhardt et al., 2001, Della Lunga et al., 2014, Sneed et al., 2015). We will present first results of both approaches with regard to the evaluation of the potential of trace elements as environmental proxies in glaciers partially affected by melting.

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