

Characterization of solid particles in East Siberian ice wedge

Subon Ko

Environmental Geochemistry Lab.

An ice wedge is a large mass of ice that grows from precipitation and soil in thermal contraction cracks over vast time scales in permafrost regions. Ice wedges typically contain higher concentrations of solutes and solids than ice cores. Because of these features and their distribution, ice wedges have been regarded as an alternative archive for reconstructing the paleoclimate and paleoenvironment. To date, studies have largely focused on the use of water isotopes and greenhouse gases in the ice wedge for paleoclimate reconstruction. However, an in-depth investigation of the paleoenvironment using features of solid particles inside the ice wedge has been overlooked. In this study, we investigated these solid particle features in ice wedges in an attempt to find proxies that can be used as a paleoenvironmental archive.

Ice wedge samples from East Siberia were used in this study. Ice wedge samples were treated with a suitable thawing process that we had previously established. After thawing, the sample suspensions were filtered to separate the aqueous and solid phases. The collected solids were freeze-dried and stored in a vacuum. Before analysis, particle size fractionation was conducted by wet-sieving and centrifugation. The solid samples were analyzed using X-ray diffraction (XRD), X-ray fluorescence spectrometry (XRF), scanning electron microscopy (SEM), and X-ray absorption fine structure (XAFS) spectroscopy. XRD and XRF analyses showed the different XRD patterns and chemical compositions of the clay-sized particles. Angular quartz particles were observed in the SEM images of sand-size particles, indicating that the provenance of these particles was near the sampling site. The K-edge XANES spectrum of redox-sensitive elements, Fe and Mn, were obtained and compared with those of reference silicate minerals and Fe or Mn oxides. These results through the lens of conventional methods (e.g., chemical weathering index, grain morphology) could be applied to establish the provenance, degree of weathering, and mineral phases of solid particles in ice wedges, and ultimately serve as an alternative or complementary to existing metrics in paleoenvironment reconstruction.

Keywords: Ice wedge, soil, permafrost, paleoenvironment, East Siberia