Cryo-TL study on salts for in-situ measurement system of salt inclusions in Antarctic ice core

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Antarctic ice composed of past snow contains information of past climate and environment. Sulfate ions were not adequate to an indicator of past climate and environment because they were supposed to diffuse in ice core. Recently, Ohno et al. (2005) reported that sulfate ions remained as salt inclusions in Antarctic ice by micro Raman spectroscopy and suggested that they can be available for an indicator of past climate and environment. Ion chromatography has often been used to measure sulfate ions in Antarctic ice, but it can't specify the form of sulfate ions as salt inclusions or ion impurities. Micro Raman spectroscopy can specify the spatial distribution and identify the inclusions, but take long time to analyze whole ice core samples. On the other hand, luminescence measurements are very sensitive for small amount of impurities. Thermoluminescence (TL) is one of the luminescence techniques and usually detected when sample is heated after irradiation by gamma- or X-rays. In ice core, most salts form hydrate compounds, stable at low temperature. There are no reports about their TL characteristics. In this study, we have developed cryo-TL measurement system with a spectrometer and a high-sensitive detector (EMCCD) and have investigated TL characteristic (luminescent temperature and wavelength) of synthetic salt samples.

Ice and acid samples like H_2SO_4, HNO_3, HCl, CH_3SO_3H do not show any TL in this system. Some sulfate, chloride, carbonate and methanesulfonate samples have TL peaks clearly, though TL peaks are not apparent in most nitrate samples. The results indicate that three sulfate ($CaSO_4$ $2H_2O$, Na_2SO_4 $10H_2O$, K_2SO_4), three chloride ($MgCl_2$ $12H_2O$, KCl, NH_4Cl), three carbonate ($CaCO_3$, Na_2CO_3 $10H_2O$, K_2CO_3) and one methanesulfonate ($Mg(CH_3SO_3)_2$) will be detectable, if we measure TL from polar ice using a photon multiplier tube (PMT).