

Luminescence study on ice and salts for an analysis of salt inclusions in Antarctic ice core by thermoluminescence

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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 hole 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 TL measurement system from 77 to 270 K and have investigated TL characteristic (luminescent temperature and color) of salts proposed for salts inclusions in Antarctic ice to discuss whether this TL method is useful to analyze the impurities included in Antarctic ice.

TL measurement system was settled in a freezer. Photomultiplier (Hamamatsu R649 or R585) was used to detect luminescence by photon counting. An optical filter was set between the detector and sample stage to check the color of TL. Commercial reagents of sodium sulfate decahydrate ($\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$) and calcium sulfate dihydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) were used as samples for salt inclusions. Antarctic ice (Vostok) and synthetic ice are also prepared. These samples were irradiated by gamma-rays of about 10 kGy at 77 K.

The ice shows UV-blue TL only below 130 K, which indicates that UV-blue TL above 130 K may be due to some impurities. Sodium sulfate decahydrate shows a few peaks in UV-blue TL above 130 K. TL of the Antarctic ice was alike to TL of sodium sulfate decahydrate. This suggests that TL can be used for analysis of salts inclusions in Antarctic ice core.