Distinguishing the Asian dust in the ice core and sediment trap samples using cathodoluminescence spectra of single quartz grains

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At present, large amounts of eolian dust are emitted from the huge dry areas of East Asia. The dust particles derived from Asian deserts are transported to the northwestern North Pacific by the westerlies, and they are sometimes transported to Canada and the United States through the westerly jet (e.g., Zdanowicz et al., 2006). Thus, Asian dust is considered to have significant effects on the natural environment, e.g., the primary productivity in the North Pacific through the supply of micronutrient iron (Maher et al., 2010), and is also key for understanding past atmospheric circulation.

Recently, we developed a new provenance-tracing method using cathodoluminescence (CL) spectral analysis of single quartz grains that is applicable to dust-fall samples, marine sediments, and ice cores far from Asian deserts (Nagashima et al., 2017). CL spectroscopy can detect crystal-chemical features in quartz such as impurities and intrinsic imperfections that depend on the conditions affecting quartz from its formation onward. Systematic CL analysis was performed on quartz grains from two Asian deserts, the Taklimakan and Gobi deserts, and we found most quartz grains from desert showed two CL emission bands in red and blue regions, which were deconvolved to at most five emission components, each representing a specific defect due to an impurity or imperfection. The statistical analysis using the ratios of emission components exhibits different ratios of clusters between the quartz grains from the two deserts, probably reflecting mixing ratios of different host-rocks (volcanic, plutonic and metamorphic rocks) constituting two deserts (Nagashima et al., 2017).

In addition, the common feature of the two deserts, the primary abundance of cluster 1 due to the abundance of low-grade metamorphic rocks related to the post-Paleozoic continental collisions of this area (Cao et al., 2015), allows the identification of Asian dust from North Pacific sediments due to the large contrast of bedrock type of the island arcs along the North Pacific margin, which is dominated by volcanic rocks (Nagashima et al., 2017). This new method could provide information on the provenance of trans-Pacific dust through application to small (approximately nanogram quantities) samples collected far from East Asia to elucidate the role of dust in global climate. Then here we apply this method to the sediment trap samples from station K2 (47N, 160E) in the western Subarctic Pacific and ice core samples from Mt. Logan (60N, 141E), Canada, to estimate the Asian dust deposition flux, provenance, and its seasonal variation along the long-distance transport path. In the presentation, we will introduce this new provenance tracing method and preliminary results of its application to the sediment trap and ice core samples.

Keywords: Asian dust, Cathodoluminescence, Quartz, Provenance Study, Ice Core, Sediment Trap

