Effects of natural and anthropogenic substances on atmospheric deposition in the Kyoto-Osaka-Kobe area using strontium and lead isotope ratios

Ryota Ando[1], *Yoriko Yokoo[1], Naoto Ishikawa[2], Ki-Cheol SHIN[3]

1. Faculty of Science and Engineering, Doshisha University, 2. Faculty of Sustainable Design, Toyama University, 3. RIHN

In order to evaluate the atmospheric environment, strontium and lead isotope ratios of monthly soluble particles (precipitation; < 0.2 μm) and solid particles (air dust; > 0.2 μm) in rainwater samples were determined. Rainwater samples were collected in Kyoto city and Kyotanabe city (Kyoto prefecture), in Neyagawa city (Osaka prefecture) and in Nishinomiya city (Hyogo prefecture) from January 2010 to December 2011. Sr isotope ratios ($^{87}Sr/^{86}Sr$) and Pb isotope ratios ($^{207}Pb/^{206}Pb$, $^{208}Pb/^{206}Pb$) of the precipitation and the dust after filtering rainwater samples were analyzed using MC-ICPMS.

Monthly $^{87}Sr/^{86}Sr$ of the precipitation ranged from 0.7087 to 0.7107 and monthly $^{87}Sr/^{86}Sr$ of the dust ranged from 0.7081 to 0.7171. Both $^{87}Sr/^{86}Sr$ were higher during spring, and lower during summer and autumn. Higher $^{87}Sr/^{86}Sr$ during spring showed the close value of Chinese loess which is an origin substance of yellow sand. The maximum $^{87}Sr/^{86}Sr$ in Kyotanabe in 2010 was higher than that in 2011. According to the Meteorological Agency, yellow sand was transported much in the spring of 2010 compared to 2011. These results indicate that yellow sand is one of the origin of the dust and the influence of yellow sand on the dust varied depending on the year.

Monthly $^{207}Pb/^{206}Pb$ of the precipitation ranged from 0.859 to 0.889 and $^{208}Pb/^{206}Pb$ ranged from 2.093 to 2.137. Monthly $^{207}Pb/^{206}Pb$ of the dust ranged from 0.851 to 0.891 and $^{208}Pb/^{206}Pb$ ranged from 2.084 to 2.140. Pb isotope ratios of precipitation and dust were almost the same. Monthly $^{207}Pb/^{206}Pb$ and $^{208}Pb/^{206}Pb$ increased in the order of Kyoto, Kyotanabe, Neyagawa, and with Nishinomiya having the most increase. Values varied depending on the sampling seasons. In Kyoto, monthly Pb isotope ratios of the precipitation and the dust had a narrow range; $^{207}Pb/^{206}Pb$ ranged from 0.859 to 0.866 and $^{208}Pb/^{206}Pb$ ranged from 2.097 to 2.109. These indicated that Pb in the precipitation and dust at Kyoto had one substance with a certain Pbisotope ratio or had multiple Pb sources mixed at the same rate throughout the year. Kyoto is located in a mountain basin, and the inflow and outflow of air could be less than that of the other three locations. Therefore, monthly Pb isotope ratios may have changed less throughout the year. On the other hand, in Kyotanabe, Neyagawa and Nishinomiya, Pb isotope ratios varied widely depending on the sampling seasons. These results show that there were multiple sources of Pb in both precipitation and the dust and the mixing ratio changed depending on the season. In Kyotanabe and Nishinomiya, precipitation and dust showed higher Pb isotope ratios in winter, suggesting that they are affected by the transported Pb with high isotope ratio from the Asian continent.

Keywords: rainwater, Sr isotope, Pb isotope

