Detection of very low isotope ratio of iron in anthropogenic aerosols and investigation of their sources

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It has been reported that primary production in the High Nutrient-Low Chlorophyll regions is limited by dissolved iron (DFe) concentration [1]. Anthropogenic aerosol is considered to be one of the important sources of DFe to the surface ocean because of its high content of Fe soluble fraction [2, 3]. However, few researches on this topic have been studied by Fe stable isotope ratio (δ^{56}Fe(‰) = 1000× [(^{56}Fe/^{54}Fe)$_{sample}$/(^{56}Fe/^{54}Fe)$_{IRMM\text{-}014}$]−1) which is an important tool to know the contribution of Fe to the surface ocean.

In this study, seven size-fractionated aerosol samples were collected in Hiroshima, Japan. Concentrations of DFe, extracted by simulated rainwater were determined by inductively coupled plasma mass spectrometry (ICP-MS). Fe stable isotope ratio was analyzed through multicollector ICP-MS. In addition, Fe chemical species were determined using X-ray Absorption Fine Structure (XAFS) spectroscopy. Aerosols collected during a biomass burning event were also analyzed as a possible emission source of anthropogenic Fe.

It was found that the fine particles (mainly of anthropogenic origin) were more soluble than the coarse particles, containing relatively a large amount of Fe (hydr)oxides. δ^{56}Fe values of the fine particles (–0.56‰ to –2.01‰) were lower than the coarse particles (0.04‰ to 0.30‰). In addition, δ^{56}Fe values of the DFe in the fine particles were found to be much lower (–1.86‰ to –3.91‰) than those of total Fe. These findings suggest that anthropogenic aerosols with high content of Fe soluble fraction yielded low δ^{56}Fe values. These low δ^{56}Fe values in anthropogenic aerosols can be explained by the kinetic isotope fractionation during combustion at high temperatures coupled with refractory characteristics of Fe. Based on the Fe isotope analysis, we found that the biomass burning is not responsible for the low δ^{56}Fe value.

These results are important to quantitatively estimate the contribution of anthropogenic Fe to the surface ocean.

[1] Martin & Fitzwater (1988), *Nature* **331**, 341–343. [2] Sedwick *et al*. (2007), *Geochem. Geophys. Geosyst.* **8**, 1–41. [3] Takahashi *et al*. (2013), *Atmos. Chem. Phys.* ***13***, 7695–7710.