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Isotope ratios of trace metals in the atmospheric aerosols collected at the station facing the Japan Sea

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Trace metals, such as Fe, Ni, Cu, Zn, Cd, and Pb, are essential or toxic to marine organisms. A source of trace metals in seawater is atmospheric aerosols. Atmospheric aerosol particles consist of natural materials including mineral dust and sea-salt as well as anthropogenic particles emitted from human activities. We have estimated the sources of trace metals in atmospheric aerosols base on their concentrations and isotopic ratios.

Atmospheric aerosol particles were collected at the NOTOGRO station facing the Sea of Japan using a large-volume aerosol sampler equipped with a cascade impactor that separated aerosol particles into seven fractions by size. Each sampling period lasted 7 days and was conducted monthly from 2020 to 2022. Samples were digested and concentrations of Na, Mg, Al, Ca, K, Ti, V, Fe, Co, Ni, Cu, Zn, Cd, Sb, and Pb were determined. In addition, isotope ratios of Fe, Ni, Cu, Zn, Cd, and Pb were determined using multi-elemental isotopic analysis[1]. Concentrations of Na, Mg, Al, Ca, K, Ti, Co, and Fe were high in coarse particles (>2 μm), indicating that the main source of these elements are mechanically generated particles, such as mineral dust, road dust and sea-salt. On the other hand, concentrations of Zn, Cd, Sb, and Pb were high in fine particles (<2 μm). This suggest that these elements are emitted to the atmosphere via vaporization by high-temperature processes, such as fossil fuel combustion and the metallurgical industry. Concentrations of V, Ni, and Cu were similar in both fine and coarse particles, indicating that mineral/road dust and particles generated in high temperature processes contribute comparable proportions to the source of these elements. For Ni, Cu, and Zn, the lighter isotopes are enriched in the fine particles. This is due to preferential vaporization of the lighter isotopes, which is consistent with the higher concentrations of these elements in fine particles. Pb isotope ratios were in the range of Chinese Pb ore for coarse particles and in the range of Middle Eastern petroleum for fine particles.

[1] Takano, S. et al. (2024), *ACS Earth and Space Chemistry* 8(3), 547-553.