Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.9890

Stable iron isotope as a tool to apportion atmospheric iron in urban and marine aerosols

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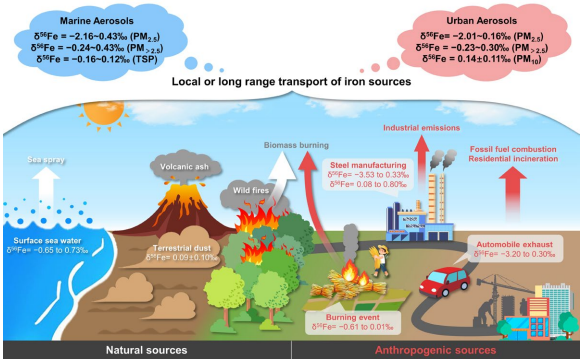

Iron (Fe) is one of the most abundant elements in the Earth's crust, playing an important role in geochemical processes, and is also an important trace component in atmospheric aerosols. Mineral dust is conventionally regarded as a major source of atmospheric iron, although the solubility of Fe in mineral dust is naturally limited (< 0.5%). In the last decades, much attention has been paid to the anthropogenic (pyrogenic) processes which release particles with higher Fe bioavailability. Atmospheric sources of iron have been studied and reviewed previously. However, a landscape of iron sources is rarely understood in both urban and marine aerosols. With the rapid development of non-traditional (metal) stable isotopes technologies, stable iron isotope analysis has become an effective tool to trace iron in atmospheric particles. In this study, we briefly summarize the recent progress of atmospheric iron isotope geochemistry. The total iron isotopic compositions (δ^{56}Fe, by reference to the IRMM-014 standard) of atmospheric aerosols range from -2.16‰ to 0.43‰ according to previous observations. Natural and anthropogenic aerosol sources including mineral dust (~0.09‰), automobile exhaust (-3.2‰ to 0.3‰), steel manufacturing (-3.53‰ to 0.33‰) have distinct δ^{56}Fe characteristics, indicating the potential of iron isotopes in tracing aerosol sources. Moreover, a Bayesian isotopic mixing model "MixSIAR" is used to quantificationally re-evaluate the contributions of different sources to iron in both urban and marine aerosols based on reported δ^{56}Fe data [1-3]. Our results indicate that East Asian air masses are much perturbed with anthropogenic emission (up to 50%), while North Atlantic aerosols are dominant by natural sources, e.g., aeolian dust (up to 54%) and sea spray (~40%). The study highlights the importance of stable iron isotope analyses as a new tool in tracing atmospheric iron.

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[2] Conway, Hamilton, Shelley, Aguilar-Islas, Landing, Mahowald & John (2019), Nat. Commun. 10, 2628.

[3] Kurisu, Takahashi, Lizuka & Uematsu (2016), J. Geophys. Res. Atmos. 121, 11119-11136.