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Table S1. Summary of $\delta^{56}\text{Fe}$ values for aerosols from relevant sources.

Table S2. Summary of $\delta^{56}\text{Fe}$ for ambient aerosols.

1 **Table S1.** Summary of $\delta^{56}\text{Fe}$ values for aerosols from relevant sources.

Sample	$\delta^{56}\text{Fe}$ for total Fe (‰)	$\delta^{56}\text{Fe}$ for dissolved Fe (‰)	Ref.
desert dust aerosols			
loess	$+0.05 \pm 0.04^a$	not reported	Beard et al., 2003
soil	$+0.04 \pm 0.07^a$	not reported	Beard et al., 2003
urban dust	-0.15 to +0.12	not reported	Beard et al., 2003
desert dust	$+0.04 \pm 0.10^b$	not reported	Fantle and DePaolo, 2004
desert soil	$+0.08 \pm 0.04^a$	not reported	Waeles et al., 2007
soil	-0.10 to 0.14	not reported	Majestic et al., 2009a
desert dust	$+0.09 \pm 0.04^a$	not reported	Mead et al., 2013
soil	$+0.04 \pm 0.20^a$	not reported	Kurisu and Takahashi, 2019
desert dust	-0.09 ± 0.07	not reported	Chen et al., 2020
desert dust	$+0.09 \pm 0.15^a$	not reported	Li et al., 2022
anthropogenic aerosols			
coal fly ash	$+0.33 \pm 0.37^a$	not reported	Li et al., 2022
coal fly ash	$+0.35 \pm 0.23^a$	not reported	Mead et al., 2013
municipal waste fly ash	$+0.10 \pm 0.08^b$	not reported	Li et al., 2022
oil fly ash	$+0.30 \pm 0.17^a$	not reported	Mead et al., 2013
diesel particulate matter	-0.03 ± 0.13^b	not reported	Mead et al., 2013

fly ash (incinerator)	-0.10±0.03 ^b	-1.97±0.18	Kurisu et al., 2016a
TSP (incinerator)	-0.66±0.09 ^b	not reported	Kurisu et al., 2016a
bottom ash (incinerator)	-0.08±0.09 ^b	-0.34±0.14	Kurisu et al., 2016a
Industrial ash	-0.12±0.04	-0.78 to -0.30	Maters et al., 2022
reed residual ash	+0.09±0.03 ^a	not reported	Kurisu and Takahashi, 2019
bulk aerosol (tunnel)	-3.16 to 0.3	not reported	Kurisu et al., 2016a
PM _{>2.5} (parking structure)	+0.15±0.03 ^a	not reported	Majestic et al., 2019b
PM _{2.5} (parking structure)	+0.18±0.03 ^a	not reported	Majestic et al., 2019b
metallurgy fly ash	+0.08 to 0.80	not reported	Flament et al., 2008
raw materials			
gasoline	+0.28±0.13 ^b	not reported	Kurisu et al., 2016a
waste oil	+0.04 to 0.11	not reported	Majestic et al., 2019b
metallic brake pad	+0.19	not reported	Majestic et al., 2019b
ceramic brake pad	+0.42 to +0.61	not reported	Majestic et al., 2019b
tire tread	-0.08 to +0.12	not reported	Majestic et al., 2019b
enriched ores	-0.16 to +1.19	not reported	Flament et al., 2008
wheat leaf	-0.05 to -0.02	not reported	Guelke and von Blanckenburg,
wheat stem	+0.09 to +0.17	not reported	2007
soybean leaf	-0.48 to -0.30	not reported	

soybean stem	-0.70 to -0.24	not reported	
oat leaf	-0.01 to +0.09	not reported	
oat stem	+0.06 to +0.07	not reported	
reed	+0.08±0.10 ^a	not reported	Kurusu and Takahashi, 2019

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5 **Table S2.** Summary of $\delta^{56}\text{Fe}$ for ambient aerosols.

Sampling site	Aerosol	$\delta^{56}\text{Fe}$ for total Fe (‰)	$\delta^{56}\text{Fe}$ for dissolved Fe (‰)	Ref.
Jeju, Korea	TSP	range: +0.00 to 0.21; mean: +0.11±0.07	not reported	Beard et al.,
Dunhuang, China	TSP	range: -0.06 to -0.01; mean: -0.04±0.04	not reported	2003
Atlantic	not specified	mean: +0.04±0.09	average: +0.13±0.18‰	Waeles et al.,
				2007
Dunkirk, France	TSP	mean: +0.14±0.11	not reported	Flament et al.,
				2008
Phoenix, USA	PM ₁₀	range: -0.23 to +0.04; mean: -0.07±0.11	not reported	Majestic et al.,
	PM _{2.5}	range: -0.55 to -0.22; mean: -0.42±0.14		2009a
Bermuda	PM _{>2.5} (dust)	range: -0.05 to +0.16; mean: +0.10±0.05	not reported	Mead et al.,
	PM _{2.5} (dust)	range: +0.00 to +0.16; mean: +0.08±0.05		2013
	PM _{>2.5} (non-dust)	range: -0.04 to +0.24; mean: +0.10±0.06		
	PM _{2.5} (non-dust)	range: -0.46 to +0.14; mean: -0.10±0.14		
Western equatorial Pacific	not specified	range: +0.27 to +0.38; mean: +0.33±0.06	not reported	Labatut et al.,
				2014
Hiroshima, Japan	size-segregated (March)	range: -1.59 to +0.23	range: -2.58 to 0.47	Kurisu et al.,
	size-segregated (August)	range: -2.01 to +0.30	range: -3.91 to -0.24	2016b
NW Pacific	PM _{>2.5}	range: -0.32 to -0.11; mean: -0.22±0.11	not reported	

	PM _{2.5}	range: -1.72 to -1.17; mean: -1.45±0.28		Kurusu et al., 2016b
Chiba, Japan	TSP	range: -3.53 to +0.33; mean: -0.52±1.02	range: -4.08 to +0.25	Kurusu et al., 2019
Tochigi, Japan	bulk aerosol (BB)	range: -0.61 to +0.13	not reported	Kurusu and
	bulk aerosol (non-BB)	range: -1.26 to +0.17	not reported	Takahashi,
	0.39-0.69 µm (BB)	range: -0.61 to -0.36	range: -0.73 to -0.50	2019
	0.39-0.69 µm (non-BB)	range: -1.26 to -1.06	range: -1.93 to -1.33	
North Atlantic	TSP (Sahara dust)	range: +0.08 to +0.17; mean: +0.12±0.03	range: +0.05 to +0.12; mean: +0.09±0.02	Conway et al., 2019
	TSP (anthropogenic)	range: -0.16 to -0.04; mean: -0.12±0.06	range: -1.58 to -1.07; mean: -0.91	
NW Pacific	PM _{>2.5}	range: -0.24 to +0.43; mean: +0.15±0.18	-0.27±0.02	Kurusu et al.,
	PM _{2.5}	range: -2.16 to +0.43; mean: -0.33±0.83	range: -2.23 to -1.14; mean: -1.69±0.55	2021
Subarctic North	TSP	range: -0.47 to +0.45	range: -1.87 to +0.28	Kurusu et al.,
Pacific	size-segregated	range: -2.82 to +0.48	not reported	2024
East China Sea	0.57-1.0 µm	range: -3.35 to -0.45	range: -4.46 to -1.33	Hsieh and Ho,
	1.0-1.6 µm	range: -1.16 to -0.06	range: -1.66 to +0.01	2024
	1.6-3.1 µm	range: -0.08 to +0.10	range: -0.16 to +0.26	
	3.1-7.3 µm	range: +0.00 to +0.16	range: -0.11 to +0.36	

	>7.3 μm	range: -0.06 to +0.14	range: -0.11 to +0.40	
North Pacific	TSP	range: -0.03 to +0.41	range: -1.28 to +0.02	Bunnell et al.,
	<0.49-0.95 μm (fine)	range: -0.39 to +0.36	not reported	2025
	>0.95 μm (coarse)	range: +0.02 to +0.27	not reported	
Equatorial and Tropical Pacific	>1 μm	range: -0.16 to +0.47	not reported	Camin et al., 2024

References:

- Beard, B. L., Johnson, C. M., Von Damm, K. L., and Poulson, R. L.: Iron isotope constraints on Fe cycling and mass balance in oxygenated Earth oceans, *Geology*, 31, 629-632, doi: DOI10.1130/0091-7613(2003)1031<0629:IICOF>1132.1130.CO;1132, 2003.
- Bunnell, Z. B., Sieber, M., Hamilton, D. S., Marsay, C. M., Buck, C. S., Landing, W. M., John, S. G., and Conway, T. M.: The influence of natural, anthropogenic, and wildfire sources on iron and zinc aerosols delivered to the North Pacific Ocean, *Geophys. Res. Lett.*, 52, e2024GL113877, <https://doi.org/10.11029/112024GL113877>, 2025.
- Camin, C., Lacan, F., Pradoux, C., Labatut, M., Johansen, A., and Murray, J. W.: Iron isotopes reveal significant aerosol dissolution over the Pacific Ocean, *EGU sphere*, 2024, 1-30, 10.5194/egusphere-2024-3777, 2024.
- Chen, T., Li, W., Guo, B., Liu, R., Li, G., Zhao, L., and Ji, J.: Reactive iron isotope signatures of the East Asian dust particles: Implications for iron cycling in the deep North Pacific, *Chem. Geol.*, 531, 119342, <https://doi.org/10.1016/j.chemgeo.2019.119342>, 2020.
- Conway, T. M., Hamilton, D. S., Shelley, R. U., Aguilar-Islas, A. M., Landing, W. M., Mahowald, N. M., and John, S. G.: Tracing and constraining anthropogenic aerosol iron fluxes to the North Atlantic Ocean using iron isotopes, *Nature Comm.*, 10, 2628, DOI: 2610.1038/s41467-41019-10457-w, 2019.
- Fantle, M. S. and DePaolo, D. J.: Iron isotopic fractionation during continental weathering, *Earth and Planetary Science Letters*, 228, 547-562, DOI: 510.1016/j.epsl.2004.1010.1013, 2004.
- Flament, P., Mattielli, N., Aimo, L., Choël, M., Deboudt, K., Jong, J. d., Rimetz-Planchon, J., and Weis, D.: Iron isotopic fractionation in industrial emissions and urban aerosols, *Chemosphere*, 73, 1793-1798, DOI: 1710.1016/j.chemosphere.2008.1708.1042, 2008.
- Guelke, M. and von Blanckenburg, F.: Fractionation of Stable Iron Isotopes in Higher Plants, *Environ. Sci. Technol.*, 41, 1896-1901, DOI: 1810.1021/es062288j, 2007.
- Hsieh, C.-C. and Ho, T.-Y.: Contribution of Anthropogenic and Lithogenic Aerosol Fe in the East China Sea, *Journal of Geophysical Research: Oceans*, 129, e2024JC021113, <https://doi.org/10.1029/2024JC021113>, 2024.
- Kurisu, M., Sakata, K., Miyamoto, C., Takaku, Y., Iizuka, T., and Takahashi, Y.: Variation of Iron Isotope Ratios in Anthropogenic Materials Emitted through Combustion Processes, *Chem. Lett.*, 45, 970-972, DOI: 910.1246/cl.160451, 2016a.
- Kurisu, M., Takahashi, Y., Iizuka, T., and Uematsu, M.: Very low isotope ratio of iron in fine aerosols related to its contribution to the surface ocean, *J. Geophys. Res.-Atmos.*, 121, 11119-11136, 2016b.
- Kurisu, M. and Takahashi, Y.: Testing Iron Stable Isotope Ratios as a Signature of Biomass Burning, *Atmosphere*, 10, 76, doi: 10.3390/atmos10020076, 2019.
- Kurisu, M., Adachi, K., Sakata, K., and Takahashi, Y.: Stable isotope ratios of combustion iron produced by evaporation in a steel plant, *ACS Earth and Space Chem.*, 3, 588-598, DOI: 510.1021/acsearthspacechem.1028b00171, 2019.
- Kurisu, M., Sakata, K., Uematsu, M., Ito, A., and Takahashi, Y.: Contribution of combustion Fe in marine

aerosols over the northwestern Pacific estimated by Fe stable isotope ratios, *Atmos. Chem. Phys.*, 21, 16027-16050, DOI: 16010.15194/acp-16021-16027-12021, 2021.

Kurisu, M., Sakata, K., Nishioka, J., Obata, H., Conway, T. M., Hunt, H. R., Sieber, M., Suzuki, K., Kashiwabara, T., Kubo, S., Takada, M., and Takahashi, Y.: Source and fate of atmospheric iron supplied to the subarctic North Pacific traced by stable iron isotope ratios, *Geochim. Cosmochim. Acta*, 378, 168-185, DOI: 110.1016/j.gca.2024.1006.1009, 2024.

Labatut, M., Lacan, F., Pradoux, C., Chmeleff, J., Radic, A., Murray, J. W., Poitrasson, F., Johansen, A. M., and Thil, F.: Iron sources and dissolved-particulate interactions in the seawater of the Western Equatorial Pacific, iron isotope perspectives, *Glob. Biogeochem. Cycle*, 28, 1044-1065, DOI: 1010.1002/2014GB004928, 2014.

Li, R., Zhang, H. H., Wang, F., He, Y. T., Huang, C. P., Luo, L., Dong, S. W., Jia, X. H., and Tang, M. J.: Mass fractions, solubility, speciation and isotopic compositions of iron in coal and municipal waste fly ash, *Sci. Total Environ.*, 838, 155974, DOI: 155910.151016/j.scitotenv.152022.155974, 2022.

Majestic, B. J., Anbar, A. D., and Herckes, P.: Stable Isotopes as a Tool to Apportion Atmospheric Iron, *Environ. Sci. Technol.*, 43, 4327-4333, doi: 4310.1021/es900023w, 2009a.

Majestic, B. J., Anbar, A. D., and Herckes, P.: Elemental and iron isotopic composition of aerosols collected in a parking structure, *Sci. Total Environ.*, 407, 5104-5109, doi: 5110.1016/j.scitotenv.2009.5105.5053, 2009b.

Maters, E. C., Mulholland, D. S., Flament, P., de Jong, J., Mattielli, N., Deboudt, K., Dhont, G., and Bychkov, E.: Laboratory study of iron isotope fractionation during dissolution of mineral dust and industrial ash in simulated cloud water, *Chemosphere*, 299, 134472, doi: 134410.131016/j.chemosphere.132022.134472, 2022.

Mead, C., Herckes, P., Majestic, B. J., and Anbar, A. D.: Source apportionment of aerosol iron in the marine environment using iron isotope analysis, *Geophys. Res. Lett.*, 40, 5722-5727, doi: 5710.1002/2013GL057713, 2013.

Waeles, M., Baker, A. R., Jickells, T., and Hoogewerff, J.: Global dust teleconnections: aerosol iron solubility and stable isotope composition, *Environ. Chem.*, 4, 233-237, DOI: 210.1071/EN07013, 2007.