

1 **Tables of contents**

2

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

4

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

6

7

8 **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±0.04 ^a | not reported | 1 |
| soil | +0.04±0.07 ^a | not reported | 1 |
| urban dust | -0.15 to +0.12 | not reported | 1 |
| desert dust | +0.04±0.10 ^b | not reported | 2 |
| desert soil | +0.08±0.04 ^a | not reported | 3 |
| soil | -0.10 to 0.14 | not reported | 4 |
| desert dust | +0.09±0.04 ^a | not reported | 5 |
| soil | +0.04±0.20 ^a | not reported | 6 |
| desert dust | -0.09±0.07 | not reported | 7 |
| desert dust | +0.09±0.15 ^a | not reported | 8 |
| anthropogenic aerosols | | | |
| coal fly ash | +0.33±0.37 ^a | not reported | 8 |
| coal fly ash | +0.35±0.23 ^a | not reported | 5 |
| municipal waste fly ash | +0.10±0.08 ^b | not reported | 8 |
| oil fly ash | +0.30±0.17 ^a | not reported | 5 |
| diesel particulate matter | -0.03±0.13 ^b | not reported | 5 |

| | | | |
|-------------------------------------------|-------------------------|----------------|----|
| fly ash (incinerator) | -0.10±0.03 ^b | -1.97±0.18 | 9 |
| TSP (incinerator) | -0.66±0.09 ^b | not reported | 9 |
| bottom ash (incinerator) | -0.08±0.09 ^b | -0.34±0.14 | 9 |
| Industrial ash | -0.12±0.04 | -0.78 to -0.30 | 10 |
| reed residual ash | +0.09±0.03 ^a | not reported | 6 |
| bulk aerosol (tunnel) | -3.16 to 0.3 | not reported | 9 |
| PM _{>2.5} (parking structure) | +0.15±0.03 ^a | not reported | 11 |
| PM _{2.5} (parking structure) | +0.18±0.03 ^a | not reported | 11 |
| metallurgy fly ash | +0.08 to 0.80 | not reported | 12 |
| <hr/> | | | |
| raw materials | | | |
| gasoline | +0.28±0.13 ^b | not reported | 9 |
| waste oil | +0.04 to 0.11 | not reported | 11 |
| metallic brake pad | +0.19 | not reported | 11 |
| ceramic brake pad | +0.42 to +0.61 | not reported | 11 |
| tire tread | -0.08 to +0.12 | not reported | 11 |
| enriched ores | -0.16 to +1.19 | not reported | 12 |
| wheat leaf | -0.05 to -0.02 | not reported | 13 |
| wheat stem | +0.09 to +0.17 | not reported | 13 |
| soybean leaf | -0.48 to -0.30 | not reported | 13 |

| | | | |
|--------------|-------------------------|--------------|----|
| soybean stem | -0.70 to -0.24 | not reported | 13 |
| oat leaf | -0.01 to +0.09 | not reported | 13 |
| oat stem | +0.06 to +0.07 | not reported | 13 |
| reed | +0.08±0.10 ^a | not reported | 6 |

9

10

11

12 **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 | 1 |
| Dunhuang, China | TSP | range: -0.06 to -0.01; mean: -0.04±0.04 | not reported | |
| Atlantic | not specified | mean: +0.04±0.09 | average: +0.13±0.18‰ | 3 |
| Dunkirk, France | TSP | mean: +0.14±0.11 | not reported | 12 |
| Phoenix, USA | PM ₁₀ | range: -0.23 to +0.04; mean: -0.07±0.11 | not reported | 4 |
| | PM _{2.5} | range: -0.55 to -0.22; mean: -0.42±0.14 | | |
| Bermuda | PM _{>2.5} (dust) | range: -0.05 to +0.16; mean: +0.10±0.05 | not reported | 5 |
| | PM _{2.5} (dust) | range: +0.00 to +0.16; mean: +0.08±0.05 | | |
| | 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 | 14 |
| Hiroshima, Japan | size-segregated (March) | range: -1.59 to +0.23 | range: -2.58 to 0.47 | 15 |
| | size-segregated (August) | range: -2.01 to +0.30 | range: -3.91 to -0.24 | |
| NW Pacific | PM _{>2.5} | range: -0.32 to -0.11; mean: -0.22±0.11 | not reported | 15 |
| | PM _{2.5} | range: -1.72 to -1.17; mean: -1.45±0.28 | | |
| Chiba, Japan | TSP | range: -3.53 to +0.33; mean: -0.52±1.02 | range: -4.08 to +0.25 | 16 |

| | | | | |
|-----------------|----------------------------------|-----------------------------------------------|--------------------------------------------------|----|
| Tochigi, Japan | bulk aerosol (BB) | range: -0.61 to +0.13 | not reported | 6 |
| | bulk aerosol (non-BB) | range: -1.26 to +0.17 | not reported | |
| | 0.39-0.69 μm (BB) | range: -0.61 to -0.36 | range: -0.73 to -0.50 | |
| | 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 \pm 0.03 | range: +0.05 to +0.12; mean: +0.09 \pm 0.02 | 17 |
| | TSP (anthropogenic) | range: -0.16 to -0.04; mean: -0.12 \pm 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 \pm 0.18 | -0.27 \pm 0.02 | 18 |
| | PM _{2.5} | range: -2.16 to +0.43; mean: -0.33 \pm 0.83 | range: -2.23 to -1.14; mean: -1.69 \pm 0.55 | |
| Subarctic North | TSP | range: -0.47 to +0.45 | range: -1.87 to +0.28 | 19 |
| Pacific | size-segregated | range: -2.82 to +0.48 | not reported | |
| East China Sea | 0.57-1.0 μm | range: -3.35 to -0.45 | range: -4.46 to -1.33 | 20 |
| | 1.0-1.6 μm | range: -1.16 to -0.06 | range: -1.66 to +0.01 | |
| | 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 | 21 |
| | <0.49-0.95 μm (fine) | range: -0.39 to +0.36 | not reported | |
| | >0.95 μm (coarse) | range: +0.02 to +0.27 | not reported | |

14 **References:**

- 15 1. Beard, B. L.; Johnson, C. M.; Von Damm, K. L.; Poulson, R. L., Iron isotope constraints
16 on Fe cycling and mass balance in oxygenated Earth oceans. *Geology* **2003**, *31*, 629-632.
- 17 2. Fantle, M. S.; DePaolo, D. J., Iron isotopic fractionation during continental weathering.
18 *Earth and Planetary Science Letters* **2004**, *228*, 547-562.
- 19 3. Waeles, M.; Baker, A. R.; Jickells, T.; Hoogewerff, J., Global dust teleconnections: aerosol
20 iron solubility and stable isotope composition. *Environmental Chemistry* **2007**, *4*, 233-
21 237.
- 22 4. Majestic, B. J.; Anbar, A. D.; Herckes, P., Stable Isotopes as a Tool to Apportion
23 Atmospheric Iron. *Environmental Science & Technology* **2009**, *43*, 4327-4333.
- 24 5. Mead, C.; Herckes, P.; Majestic, B. J.; Anbar, A. D., Source apportionment of aerosol iron
25 in the marine environment using iron isotope analysis. *Geophysical Research Letters* **2013**,
26 *40*, 5722-5727.
- 27 6. Kurisu, M.; Takahashi, Y., Testing Iron Stable Isotope Ratios as a Signature of Biomass
28 Burning. *Atmosphere* **2019**, *10*, 76.
- 29 7. Chen, T.; Li, W.; Guo, B.; Liu, R.; Li, G.; Zhao, L.; Ji, J., Reactive iron isotope signatures
30 of the East Asian dust particles: Implications for iron cycling in the deep North Pacific.
31 *Chemical Geology* **2020**, *531*, 119342.
- 32 8. Li, R.; Zhang, H.; Wang, F.; He, Y.; Huang, C.; Luo, L.; Dong, S.; Jia, X.; Tang, M., Mass
33 fractions, solubility, speciation and isotopic compositions of iron in coal and municipal
34 waste fly ash. *Science of the Total Environment* **2022**, *838*, 155974.
- 35 9. Kurisu, M.; Sakata, K.; Miyamoto, C.; Takaku, Y.; Iizuka, T.; Takahashi, Y., Variation of
36 Iron Isotope Ratios in Anthropogenic Materials Emitted through Combustion Processes.
37 *Chemistry Letters* **2016**, *45*, 970-972.
- 38 10. Maters, E. C.; Mulholland, D. S.; Flament, P.; de Jong, J.; Mattielli, N.; Deboudt, K.;
39 Dhont, G.; Bychkov, E., Laboratory study of iron isotope fractionation during dissolution
40 of mineral dust and industrial ash in simulated cloud water. *Chemosphere* **2022**, *299*,
41 134472.
- 42 11. Majestic, B. J.; Anbar, A. D.; Herckes, P., Elemental and iron isotopic composition of
43 aerosols collected in a parking structure. *Sci Total Environ* **2009**, *407*, 5104-5109.
- 44 12. Flament, P.; Mattielli, N.; Aïmoz, L.; Choel, M.; Deboudt, K.; de Jong, J.; Rimetz-
45 Planchon, J.; Weis, D., Iron isotopic fractionation in industrial emissions and urban
46 aerosols. *Chemosphere* **2008**, *73*, 1793-1798.
- 47 13. Guelke, M.; Von Blanckenburg, F., Fractionation of stable iron isotopes in higher plants.

- 48 *Environmental Science & Technology* **2007**, *41*, 1896-1901.
- 49 14. Labatut, M.; Lacan, F.; Pradoux, C.; Chmeleff, J.; Radic, A.; Murray, J. W.; Poitrasson, F.;
50 Johansen, A. M.; Thil, F., Iron sources and dissolved-particulate interactions in the
51 seawater of the Western Equatorial Pacific, iron isotope perspectives. *Global*
52 *Biogeochemical Cycles* **2014**, *28*, 1044-1065.
- 53 15. Kurisu, M.; Takahashi, Y.; Iizuka, T.; Uematsu, M., Very low isotope ratio of iron in fine
54 aerosols related to its contribution to the surface ocean. *Journal of Geophysical Research-*
55 *Atmospheres* **2016**, *121*, 11119-11136.
- 56 16. Kurisu, M.; Adachi, K.; Sakata, K.; Takahashi, Y., Stable Isotope Ratios of Combustion
57 Iron Produced by Evaporation in a Steel Plant. *Acs Earth and Space Chemistry* **2019**, *3*,
58 588-598.
- 59 17. Conway, T. M.; Hamilton, D. S.; Shelley, R. U.; Aguilar-Islas, A. M.; Landing, W. M.;
60 Mahowald, N. M.; John, S. G., Tracing and constraining anthropogenic aerosol iron fluxes
61 to the North Atlantic Ocean using iron isotopes. *Nature Communications* **2019**, *10*, 2628.
- 62 18. Kurisu, M.; Sakata, K.; Uematsu, M.; Ito, A.; Takahashi, Y., Contribution of combustion
63 Fe in marine aerosols over the northwestern Pacific estimated by Fe stable isotope ratios.
64 *Atmospheric Chemistry and Physics* **2021**, *21*, 16027-16050.
- 65 19. Kurisu, M.; Sakata, K.; Nishioka, J.; Obata, H.; Conway, T. M.; Hunt, H. R.; Sieber, M.;
66 Suzuki, K.; Kashiwabara, T.; Kubo, S.; Takada, M.; Takahashi, Y., Source and fate of
67 atmospheric iron supplied to the subarctic North Pacific traced by stable iron isotope ratios.
68 *Geochimica Et Cosmochimica Acta* **2024**, *378*, 168-185.
- 69 20. Hsieh, C. C.; Ho, T. Y., Contribution of Anthropogenic and Lithogenic Aerosol Fe in the
70 East China Sea. *Journal of Geophysical Research-Oceans* **2024**, *129*, e2024JC021113.
- 71 21. Bunnell, Z. B.; Sieber, M.; Hamilton, D. S.; Marsay, C. M.; Buck, C. S.; Landing, W. M.;
72 John, S. G.; Conway, T. M., The Influence of Natural, Anthropogenic, and Wildfire
73 Sources on Iron and Zinc Aerosols Delivered to the North Pacific Ocean. *Geophysical*
74 *Research Letters* **2025**, *52*, e2024GL113877.