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Authigenic, biogenic and lithogenic particulate Fe estimates from GP19 and GP22 GEOTRACES cruise data

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Iron (Fe) is an essential micro-nutrient for phytoplankton growth and important in regulating carbon cycle. Bioavailable dissolved Fe in seawater is supplied through dissociation/release from organic compounds and marine particles. Particulate Fe is comprised of authigenic, biogenic and lithogenic fractions. Each fraction is different in supply efficiencies of dissolved Fe. For example, authigenic Fe is introduced as a key source of dissolved Fe (Tagliabue et al., 2023) while lithogenic crystalline minerals hardly release Fe into solution. In this study, we estimate particulate Fe fractions using trace element observations during the GP19 and GP22 GEOTRACES cruises in the Pacific Ocean.

Total particulate Fe (>0.2 μm) was determined by ICP-MS. Biogenic Fe was calculated using particulate phosphorus concentrations multiplied by reported Fe:C and C:organic phosphorus molar ratios (Sofen et al., 2023). Lithogenic Fe was calculated using particulate aluminum concentrations multiplied by Fe:Al ratios in the upper continental crust (Taylor and MacLennan, 1995; Hu and Gao, 2008). Authigenic Fe was obtained as total pFe concentrations minus sum of the two Fe fractions.

Total pFe concentrations vary from the lowest value of 0.04 nmol/kg in oligotrophic South Pacific surface water to the highest value exceeding 10 nmol/kg near the seafloor. At depths of 10–50 m at most stations, biogenic Fe with concentrations ranging from 0.04–0.13 nmol/kg except for values of 0.39±0.23 nmol/kg (n = 15) in the Subarctic North Pacific is a major contributor to total pFe pool (48–79%), while authigenic Fe contributions are small (< ~8%). At depths of 100–200 m, the percentage of authigenic Fe is relatively high, a significant fraction of pFe pool (15–37% for most stations). Authigenic and lithogenic Fe concentrations in the subsurface water are found in the order of Subarctic North>Equatorial>Subtropical North>other regions, implying Subarctic North Pacific phytoplankton assemblages may be more efficiently fueled with particle-originated Fe. Authigenic and lithogenic Fe in intermediate and deep waters are highest at the subarctic North Pacific. These two fractions show a strong correlation ($R > 0.9$). Finally, biogenic Fe estimation in the present study needs improved in the future as it is based on reported data from subtropical region.