

EGU2020-10721

<https://doi.org/10.5194/egusphere-egu2020-10721>

EGU General Assembly 2020

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Quantifying the role of volcanic ash supply in the oceanic iron and manganese cycles

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Primary productivity in the upper ocean is a key driver of Earth's carbon cycle. The supply of micronutrients such as iron (Fe) and manganese (Mn) to the ocean is now known to exert a controlling influence on net primary productivity. Fragmental volcanic material, or tephra, is enriched in such nutrients, highly reactive and regularly supplied to the upper ocean when eruptions occur. However, there are no existing estimates of the global magnitude of the volcanic supply of these (and associated) nutrients to the oceans. Here we present new data from ten volcanic provinces globally including the Aleutian Islands and Lesser Antilles to estimate depletion factors of both Fe and Mn in altered tephra. By comparing the concentration of altered tephra to unaltered protolithic compositions, we can estimate depletion factors, and thus the amount of each element supplied to the oceans via this method. Using a novel Monte Carlo approach, we estimate mean values of Fe and Mn to be on the order of 26.1 and 0.25 Gmol yr⁻¹, respectively. These values are broadly comparable to riverine and atmospheric dust fluxes to the ocean, indicating that volcanism plays a major role in Fe and Mn ocean cycles.

How to cite: Longman, J., Palmer, M., and Gernon, T.: Quantifying the role of volcanic ash supply in the oceanic iron and manganese cycles, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-10721, <https://doi.org/10.5194/egusphere-egu2020-10721>, 2020