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Iron in Volcanic Ash: Iron-Specific Mineralogy Explains Solubility

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Since volcanic material is rich in iron (Fe), deposition of volcanic ash into the ocean is thought to stimulate marine productivity and promote carbon sequestration through relieving Fe limitation specifically. However, whether ash-derived Fe is soluble and available for uptake by marine microbes remains unclear, and ash from different eruptions varies extensively in composition and presumably solubility. In environments like the North Atlantic where mineral dust provides substantial aerosol Fe inputs, additional inputs from volcanic material have been largely overlooked, and estimates of soluble Fe release from ash are complicated by the use of different leaching techniques among the atmospheric and oceanographic communities. We used an acetic acid-based leach, which has become a staple in the oceanographic community, to measure Fe solubility for volcanic ash deposited in the North Atlantic Ocean from three recent eruptions [1]. We also used single-particle and bulk techniques to gather information about composition, morphology, and size of ash particles. Our analysis showed that the ash releases between 10 and 60 μmol soluble Fe/gram. While total Fe content undoubtedly plays a role, Fe-specific mineralogy further explains the observed differences in soluble Fe release between different ash types. The silicate and oxide content in ash varies extensively, and aerosol Fe contained in silicates is more soluble than Fe in oxide minerals [2]. For some ash, Fe is concentrated in specific regions on particle surfaces rather than uniformly coating them, and surficial fluorine (F) appears to enhance Fe solubility [3]. Overall, we estimate that Fe in volcanic ash is <5% soluble, limiting its potential to relieve Fe limitation. Still, despite its high Fe content, volcanic ash does not release significantly more soluble Fe per unit weight than other types of natural aerosols like mineral dust. Eruptions likely provide pulses of soluble Fe to the surface ocean due to abnormally high deposition fluxes rather than elevated soluble Fe content.

[1] Berger, Lippiatt, Lawrence & Bruland (2008), *Journal of Geophysical Research* 113, C00B01.

[2] Journet, Desboeufs, Karine, Caquineau & Colin (2008), *Geophysical Research Letters* 35, L07805.

[3] Jones & Gislason (2008), *Geochimica et cosmochimica acta* 72, 3661-3680.