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Assessment of bioavailability of iron delivered to marine phytoplankton in different mineralogical forms

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Iron (Fe) is an essential element in cellular biochemical processes and its availability in the surface ocean limits phytoplankton-mediated fixation of C, i.e. the biological pump. In vast regions of the open ocean, atmospheric deposition of Fe-bearing continental dust and volcanic ash to the surface ocean acts as an important source of bioavailable Fe to phytoplankton. The capacity of dust and ash to alleviate Fe limitation is usually discussed in terms of Fe solubility, which has been shown to be controlled by speciation/mineralogy. However, little information exists on the relationship between Fe bioavailability and Fe speciation/mineralogy in dust and ash. In this study, Fe-bearing materials of known mineralogy, including three volcanic ash samples from different eruptions (Eyjafjallajökull 2010, Chaitén 2008 and Tungurahua 2012), two continental dust specimens (Douz and Banizoumbou) and three Fe-bearing minerals (illite/smectite, ferrihydrite, and goethite) were added to Fe-stressed cultures of Dunaliella tertiolecta, a marine algae commonly found in high-nutrient, low chlorophyll waters. Photosynthetic activity, chlorophyll content and cell population growth were measured at regular intervals during 168 h after Fe addition. Our results indicate that all the tested Fe-bearing materials induced a similar biological response; and were able to alleviate Fe stress in D. tertiolecta within 2 h from the beginning of the experiment and to induce cell growth up to 168 h. This unexpected finding contrasts with the traditional view that Fe speciation/mineralogy in dust and ash plays a key role in governing Fe bioavailability to phytoplankton. Supplementary measurements on the fractional solubility of Fe in dust and ash will be presented.