Accelerated dissolution of iron oxides in ice media and its environmental effects

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The dissolution of iron from mineral dusts and soil particles is crucial for the bio-availability of iron in various environmental media. The bio-availability of iron has been regarded as a crucial limiting factor for the phytoplankton productivity and involved in the sequestration of atmospheric carbon dioxide(CO_2), especially in HNLC(High Nutrients Low Chlorophyll) regions such as Southern Ocean. Although the bioavailability and fate of iron in aquatic environments has been intensively investigated, those in frozen environments have rarely studied. In this study, the dissolution of iron oxide particles trapped in ice was investigated as a new pathway of iron supply both in the absence and presence of irradiation. The dissolution of iron oxides in frozen sample was significantly accelerated compared to those in aqueous solution. The outdoor experiments carried out under ambient solar radiation of Ny-lesund (Svalbard, 78 55'N) and King George Island (62°13′S 58°47′W, sea level) also confirmed that the production of bio-available iron species is enhanced when iron oxides are trapped in ice. We speculated that the freeze concentration of iron oxide particles, protons, and organic ligands in ice grain-boundaries could be the plausible reason for the enhanced dissolution of iron oxides in ice phase. Our research implies that the frozen atmospheric ice with iron-containing dust particles in the upper atmosphere may provide bioavailable iron to the ocean surface when they thaw