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Freezing-Accelerated Transformation of Iodide in Frozen Solution

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The chemistry of reactive iodine in the frozen environment may play important roles but remains unknown. Here, we present and discuss several examples of accelerated transformation of iodide ions in frozen solution. First, the production of triiodide via iodide oxidation, which is negligible in aqueous solution, is significantly accelerated in frozen solution. The emission of gaseous I_2 from the irradiated frozen solution of iodide to the gas phase was detected. The accelerated (photo)oxidation of iodide and the subsequent formation of triiodide and I_2 in ice is related to the freeze concentration of iodide and dissolved O_2 trapped in the ice crystal grain boundaries. We propose that an accelerated abiotic transformation of iodide to gaseous I_2 in ice media provides a previously unrecognized formation pathway of active iodine species in the polar atmosphere. Second, we observed that the chemical reaction between iron oxides and iodide is markedly accelerated to produce bioavailable iron (Fe(II)) and tri-iodide in frozen solution while it is negligible in aqueous phase. The freeze-enhanced production of Fe(II) and tri-iodide is also ascribed to the freeze concentration of iron oxides, iodides, and protons in the ice grain boundaries. This proposes a previously unknown abiotic mechanism and source of bioavailable iron and active iodine species in the polar environment. Lastly, we report a pathway of organoiodine compounds (OICs) formation that reactive iodine and OICs are produced from iodide oxidation in the presence of Fe(III) and natural organic matter in frozen solution whereas their production is insignificant in aqueous solution.

References

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