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Freezing-induced bromate reduction through iodide and its implications

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Freezing, which is the naturally facile process in the cold climate regions, has been extensively investigated as a non-contamination and effective cost method in the environmental treatment. The reactive halogens chemistry has a huge impact on the global environment, especially polar regions. Here, we elucidated the generation of iodine (I_2), tri-iodide (I_3^-), and bromide (Br^-) through the bromate (BrO_3^-) reduction by iodide (I^-) in the unfrozen solution of ice while it did not take place in aqueous solution. This appreciably enhanced transformation was attributed majorly to the freeze concentration effect of BrO_3^-, I^-, and protons (H^+) in the liquid boundary of ice. The ice grain boundary regions created as well as the consumption of BrO_3^- in the BrO_3^-/I^-/freezing systemin those regions during freezing were visualized with the confocal Raman microscope. pH decrease (the accumulation of H^+) during freezing was measured quantitatively by the UV-Vis absorption spectra of cresol red (as the acid-base indicator). Also, the freeze concentration effect of I^- on the BrO_3^- transformation was verified in the differently experimental conditions of pH and/or I^- concentration. The study on the acceleration of BrO_3^-/I^-/freezing system provides not only an unknown production pathway of bromine and iodine speciation in the polar environment but also the environmentally friendly insight into BrO_3^- treatment (known as the disinfection byproduct during ozonation in water treatment).