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Humic-like products formation via the reaction of phenol with nitrite in ice phase

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Understanding the chemical nature of humic substances is very important but the origin of humic substances in nature is not well known. Therefore, elucidating the mechanisms leading to the generation of humic substances in nature is of great interests. It is believed that humic substances are produced from the transformation of natural organic matters, like lignin, by biological pathways. Recently, it has been reported that monomer molecules like quinones and sugars could be polymerized with amino compounds to form humic-like substances. This humification process is considered as a possible mechanism of humic substances production in the environment. In this work, we report the first observation on the formation of humic-like substances from the reaction between phenol and nitrite under a frozen state. In aqueous solution, nitrite slowly reacts with phenol, producing phenolic compounds like nitrophenol. Under frozen state, however, phenol reacted rapidly with nitrite and produced diverse organic compounds, like hydroquinone, dimerized phenolic substances, and much bigger molecules such as humic-like substances. The humic-like substances produced in ice are likely caused by the formation of phenolic radical and nitrosonium ion. This work may provide some insights into unknown pathways for the origin of humic substances especially in frozen environments.

Significance statement

Chemical reaction in ice, Geochemistry, Organic chemistry, Reaction acceleration by freezing

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