Humic substances affect iron wheel-driven hydroxyl radical production in soil

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Hydroxyl radical (-OH) is the most reactive oxidant and plays important roles in the biogeochemical cycle of elements and the attenuation of
contaminants in the environment. In recent years, the redox reaction of iron in subsurface sediments was found to produce ·OH naturally, even in dark conditions without the presence of exogenous hydrogen peroxide. However, the effect of mineral-associated soil organic matter (SOM) on the process is not well understood.

In a study published in *Environmental Science & Technology*, a research team led by Prof. Zhu Yongguan and Li Gang from the Institute of Urban Environment of the Chinese Academy of Sciences reported the influence of humic substances, the major components of SOM, on the microbially mediated iron reduction and reoxidation processes, and established the pathway of ·OH production in different SOM-containing system.

The researchers used fulvic acid (FA), humic acid (HA), and humin (HM), components of humic substances operationally separated from soil, to evaluate the influence of SOM characteristics on iron redox processes. They found that high electron exchange capacity of FA and HA promoted the microbial iron reduction process, while HA with high electron donating capacity inhibited the yield of ·OH.

Using the scavengers of possible intermediate involved in ·OH production, the researchers established different pathways for ·OH production in SOM-containing system. They found that the one-electron transfer process dominated the ·OH production in the FA-containing system, while both one- and two-electron transfer processes were present in HA- and HM-containing systems.

Additionally, the researchers found that microbially mediated iron redox processes changed the properties of dissolved fractions of SOM, and the aromaticity of dissolved fraction of HA decreased due to its high reactivity with ·OH.
Based on the high-resolution transmission electron microscope and X-ray diffractometer, ferrous secondary minerals formed and SOM inhibited its transformation to higher stable and crystalline iron oxy(hydr)oxides.

This work advances the understanding of SOM-involved iron redox processes and ·OH production. The mechanisms revealed need to be considered when evaluating the effect of potentially produced ·OH on pollutants degradation in redox fluctuating environments.


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