Microbially Driven Production of Hydroxyl Radicals During Soil Redox Oscillations

YANTING ZHANG, MAN TONG*

State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, 388 Lumo Road, Wuhan 430074, P. R. China (tongman@cug.edu.cn)

The redox conditions of subsurface environment are often disturbed by O_2 in many natural and artificial processes (e.g., surface water and groundwater interactions and riverbank filtration treatment), leading to strong interactions between O_2 and reduced components in subsurface. Our previous study demonstrated that the oxygenation of Fe(II)–rich soils could produce hydroxyl radicals (•OH) which exert a significant impact on the fate of redox-active substances and elements [1]. Since Fe(II) could be regenerated by microbial reduction of Fe(III) during redox cycles, it is important to find out whether the production of •OH could be sustainable during soil redox oscillations. In this study, Fe-rich soils sampled from Jianghan Plain (Central China) were subjected to a series of anoxic-oxic cycles (6 d cycle length over a 36 d duration), *Shewanella oneidensis* MR-1 strain was added as a representative of facultative anaerobic dissimilatory Fe(III) reducing bacteria. Results showed that the generation of •OH maintained at around 30 μM during the first three cyles and then gradually decresed to 10 μM after the fouth cycle. MR-1 cells at 2.0×10^8 CFU/mL were killed by 1.5 orders of magnitude due to production of •OH during the multiple redox oscillations, which inhibited the regeneration of Fe(II) and the subsequent prodcution of •OH. Furthermore, X-ray adsorption spectroscopy and ^{57}Fe Mössbauer spectroscopy showed that the iron-oxide crystallinity increased during soil redox oscillation, leading to a decrease in Fe(III) bio-availability. These findings indicate that both of the inactivation of MR-1 cells and the transformation of iron oxides contribute to the unsustainable production of •OH during soil redox oscillations.