Involvement of extracellular electron transfer and microbial taxis in cotransport of biochar and cell in saturated porous media

GUANGFEI LIU[1]*, LECHENG LIU[1] AND JITI ZHOU[1]

[1]School of Environmental Science and Technology, Dalian University of Technology, Dalian 116024, China (*correspondence: guangfeiliu@dlut.edu.cn)

Introduction

It was well known that coexisting abiotic colloids and microbes could impact their respective transport behavior due to physicochemical interactions. However, the biological activity towards the coexisting abiotic colloids and its influence on their contransport have long been neglected. Biochar particle, which has been widely applied in soil for its agronomic and environmental benefits, could participate in microbial extracellular electron transfer (EET). Considering that *Shewanella* cells could exhibit an EET-dependent electrokinesis and migrate tactically towards biochar and other redox-active particles, it is interesting to study the impacts of EET and bacterial taxis activities on the cotransport behavior of biochar colloid (BC) and *Shewanella* cells in saturated porous media.

Results and Discussion

In comparison to their individual transport behaviors, the mobilities of cotransporting *Shewanella oneidensis* MR-1 cell and BC were significantly inhibited. Heteroaggregation of MR-1 cell and BC retarded their cotransport. The decreasing colloidal mobilities at higher ionic strengths signified the importance of electrostatic interaction between cell and BC in cotransport.

Moreover, the less suppressed cotransport of BC and mutants defective of EET and the elevated inhibition effects on cotransport by adding exogenous electron donor suggested the significant influence of EET. Difference in cotransport behavior was also observed with BC having different redox states. Compared with oxidized BC, reduced BC with higher hydrophobicity led to easier aggregation with cell and higher retention in the column. More importantly, MR-1 exhibited EET-dependent taxis towards biochar, which also contributed to the enhanced heteroaggregation and decreased mobilities of cell and biochar. Our results highlighted that metabolic activities of microbes towards abiotic colloids should be considered when assessing their transport behaviors, especially in subsurface environments abounded with redox-active inorganic particles and microbes performing extracellular respiration.

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