Mobilization of arsenic during reductive dissolution of As(V)-bearing jarosite by a sulfate reducing bacterium

KUN GAO, CHULING GUO, ZHI DANG*

School of Environment and Energy, South China University of Technology, Guangzhou 510006, China (*correspondence: chzdang@scut.edu.cn)

Jarosite is considered a potent scavenger for the contaminants including arsenic (As) in acid mine drainage (AMD) environments. The activity of sulfate reducing bacteria (SRB) plays an important role in controlling jarosite mineral transformation and As mobilization. In this study, the fate and transport of As during microbial reduction of As(V)-bearing jarosite in conditions with or without amended sulfate was explored. Results indicated that jarosite was mostly replaced by mackinawite in the presence of dissolved sulfate. Aqueous As experienced an initial increase due to the reductive dissolution of As-bearing jarosite, and subsequently decreased for the co-precipitation of As sulfides or adsorption of As to the newly formed secondary mineral. The production of Elemental S and total Fe(II) indicated that Fe(III) was mainly reduced by the formed sulfide chemically in systems with dissolved sulfate. In the absence of dissolved sulfate, vivianite, mackinawite, pyrite and magnetite were formed as secondary Fe minerals, though, 24.55% of the total Fe was present as aqueous Fe(II) phase. More aqueous As was released compared to that in system with dissolved sulfate amendment. At the end of the incubation, 41.99 % and 48.10 % of the total As in the solid phase released into the aqueous phase in systems with and without dissolved sulfate, respectively. The addition of dissolved sulfate mitigated the mobilization of As into the aqueous phase. During the reductive dissolution of As-bearing jarosite by SRB, the fraction of As in iron oxide surface-bound phase increased along with the decrease of the As in crystalline iron oxide-bound phase. In addition, XPS analysis indicated that As(V) was reduced to As(III) during this experiment. The risk of As release from solid phase into the surrounding environments increased. Those findings provide new insights into the evolution of iron mineralogy and associated As mobility following the establishment of reducing conditions in AMD environments.