Biotransformation of arsenic in a contaminated aquifer under varying redox conditions

HEE SUN MOON*, SUNG PIL HYUN, BO-A KIM AND YOONHO LEE

Korea Institute of Geoscience and Mineral Resources, Daejeon, 305-350, South Korea (*correspondence: hmoon@kigam.re.kr)

The mobility and toxicity of arsenic (As) are strongly influenced by the chemical speciation of the element. We studied biogeochemical redox transformations of As using columns packed with As(V)-contaminated sediment designed to simulate As-contaminated aquifers under varying redox condition. We inoculated *Geobacter sulfurreducens* to the columns along with 3 mM acetate as a carbon source in a deoxygenated artificial groundwater solution to induce microbial arsenic reduction. After 3 months operation under iron-reducing conditions, we switched the column condition to oxidizing conditions by injecting dissolved oxygen or nitrate as oxidants. We monitored the resulting arsenic release in effluent solutions, microbial community changes, and sediment characteristics in response to redox potential changes, using pyrosequencing and solid phase characterization techniques.

Fe(II) concentrations in the effluent rapidly increased up to 7 days and then decreased due to precipitation as ferrous sulfide with the reduction of sulfate in the artificial groundwater. Under the microbially achieved reducing condition, most of As(V) were reduced to As(III) and the inoculated genus *Geobacter* occupied 10~20% of the total microbial population in the columns. When columns were injected with dissolved oxygen or nitrate during the oxidizing phase of the column operation, the re-oxidation of sulfide was immediately and significantly observed in the effluent. Dissolved As concentration suggested that dissolved oxygen was more efficient oxidizer than nitrate. After injection of dissolved oxygen with acetate, the population of genus *Geobacter* significantly decreased, whereas the portion of *Desulfosporosinus* increased and *Anaerolinaceae* was newly observed. On the other hand, relatively more *Geobacter* sp. was still observed in the two columns without acetate injection. The genus *Thiobacillus* was identified in the columns, suggesting its role in sulfide oxidation. Electron microscopy and X-ray absorption spectroscopy results showed a strong correlation between As, and Fe and S minerals, indicating As association with iron sulfide phases during the reducing phase of the column operation.

The results of this study contribute to the understanding of microbially-mediated As speciation and As biogeochemistry influenced by redox conditions in the aquifers.