Microbial community function and response associated with metalloid redox transformations in the contaminated environment

*Natsuko Hamamura[1], Takafumi Kataoka[2]

1. Kyushu University, 2. Fukui Prefectural University

Arsenic (As) and antimony (Sb) are both naturally occurring toxic elements and are considered to be priority pollutants of interest by the USEPA. Although the concentrations of these toxic metalloids in the environments are generally low (~15 $\mu g\ g^{-1}$ As and <1 $\mu g\ g^{-1}$ Sb in soils), the elevated levels of As and Sb have been released via natural processes and anthropogenic activities. Both As and Sb can exist in four oxidation states (-III, 0, III and V), while they are mainly found in two oxidation states, trivalent (III) and pentavalent (V) in natural systems. The trivalent forms, As(III) and Sb(III) are highly reactive with thiol-containing proteins and are considered more toxic to biota than As(V) and Sb(V).
Despite their toxicity, microorganisms have developed mechanisms to tolerate and catalyze redox transformation of As and Sb. In this study, we characterized various microbial metalloid redox transformation pathways associated with As and Sb-impacted environments. The presence of indigenous microbial populations capable of metalloids transformation was examined by using both molecular biological and cultivation approaches. The genes coding for arsenite oxidase (*aioA*), which mainly catalyzes As(III) oxidation coupled to O_2 reduction, as well as anaerobic arsenite oxidase (*arxA*), known to catalyze As(III) oxidation coupled to nitrate reduction or photosynthesis, have been recovered from mine tailing soils. Successful cultivation of various As(III)-oxidizing bacteria confirmed the microbial attribute in As oxidation. The indigenous microbial populations catalyzing Sb redox transformation were also identified by successful cultivation of aerobic and anaerobic Sb(III)-oxidizing isolates and anaerobic enrichment cultures capable of reducing Sb(V). Furthermore, the soil microbial community response to co-contamination with As and Sb was examined by combined geochemical, cultivation and genomic approaches. The results showed varying inhibitory effects of co-contamination depending on the Sb chemical forms on As(III) oxidation rates, which were associated with selection of distinct As(III)-oxidizing population. Our study revealed the diversity of microbial metalloid redox pathways associated with polluted environments, indicating the potential importance of biological processes in geochemical cycling of As and Sb.

Keywords: Arsenic, Antimony, arsenite oxidase, arsenate reductase

