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Iron precipitation and associated microbial activities in Ainai and Shojin river mine drainages, Japan

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Active treatments have been applied as a classical method to precipitate toxic elements by injecting chemicals into mine drainages which might pollute water sources in the surrounding areas. Recently, passive treatments are focused on as a low-cost treatment which utilizes natural remediation system in on-site environments. However, the practical applications in project sites, particularly roles of microflora to form toxic elements-bearing iron precipitates are still insufficient. Here, we report influences of microbiological activities on iron precipitation by identifying components and microbial flora analysis of sediments in mine drainage channels of two sites: Ainai and Shojin river mines, Japan.

pH of the Ainai mine drainages showed 6.2 at the source of drainage, increased to 7.9 toward the downstream of the channel with decreases of As and Zn concentrations. Powder X-ray diffraction analysis and electron microscopy observations indicated that the precipitates were mainly aggregates of iron-hydroxide colloids with ~50 nm diameters with minor components of Zn-containing layered double hydroxides (LDH) and thin films of Mn-hydroxides. On the other hand, pH of the Shojin river mine drainages showed 2.5, increased to 3.5 toward the downstream of the river merged with the mine drainage. The precipitates which blocked a limestone channel at the source of drainage were mixtures of schwertmannite colloid aggregates, acidophilic diatoms, and microbially-derived carbonaceous materials such as microbes and the biofilms. Schwertmannite aggregates sometimes formed filamentous morphology on biofilms, suggesting the microbial enhancement of the iron precipitation. The results of 16SrRNA microbial flora analysis showed that most of the flora in the Ainai mine sediments were *Gallionella*, the iron-oxidizing bacteria, accounted for a high proportion (<31%), whereas the flora of the Shojin river mine sediments were dominated by cyanobacteria with the slight contribution of iron-oxidizing bacteria. Shojin River mine drainage was Fe^{2+}-poor (~0.3mg/l), which might promote cyanobacterial activities, while the Ainai mine drainage was Fe^{2+}-rich (~8mg/l), causing mild iron oxidation with the high activity of iron-oxidizing bacteria. Our results suggest microbial activities are strongly dependent on the drainage compositions and might change the fate of the consequent precipitate formations which sometimes causes blockages of open limestone channels.