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Fe and Mn behaviors in the contaminated groundwater and microorganisms used for remediation in a tank

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Groundwater chemistry and the bioremediated water, and microbes in the treated tank were traced to observe the Fe and Mn behaviors with microbial activity from summer to winter in 2009. The well water was planned to use for biotope, and the Fe and Mn should be removed before flowing into the pond. Two tanks filled with iron powder, sand, pumice, etc. were set for the purification of groundwater. The plastic pellets for bioremediation was filled in one of those tanks. Biofilms grown on plastic pellets in an aerated filter tank for groundwater remediation were analyzed for the microbiology applied PCR method and chemistry using a SEM-EWS to observe transition of microbial community and associated Fe and Mn behaviors. Well water taken from the school yard in Moriguchi,Osaka, contains high amount of Fe (15 mg/L at max) and Mn (4 mg/L at max). The well water was planned to use for biotope, and the Fe and Mn should be removed before flowing into the pond. Thus, two tanks filled with iron powder, sand, pumice, etc. were set for the purification of groundwater. The plastic pellets for bioremediation was filled in one of those tanks.
By means of PCR (polymerase chain reaction) method, the primary microbial community on the pellets was documented as the species closely related to those in karst aquifer. The microbial community was extinct one month after the filter was started to use. At that time, the water dissolved high Fe and Mn with reducing condition of the tank water. Thus, aeration had started to keep aerobic condition in the tank. Then, new microbial community propagated and was diversified. We identified microorganisms growing in aerobic condition at subsurface environment; predominantly, they were closely related to [Bacillus], [Staphylococus], [Authrobacter], and [Pseudomonas]. To observe microbially mediated concentration process of Fe and Mn in a laboratory, newly propagated microorganisms on the plastic pellets were cultivated with Fe and O 2 gradient tube. As a result, no Fe-oxidizing bacterium was found on the plastic pellets.
SEM-EWS analysis showed that the Fe and Mn were precipitated on the surface of microbium. In the summer time, Fe was abundant compared with Mn, while Mn became dominant in the autumn to winter. Iron was mostly removed from the treated water with this tank but most of the Mn remained in the summer time, while the Mn was removed effectively but not Fe in the winter. The Fe and Mn would be precipitated in association with changes of pH-Eh conditions. The microbial activity becomes active in the summer, and the water condition becomes more reducing than in the winter. Fe oxidation occurs at lower redox condition than the Mn oxidation from 2+ to 4+. However, the Fe was dissolved when the Mn was precipitated. Thus, the reduction of Fe must occur at the same timing of Mn oxidation at higher redox condition in the winter than the summer. Those results suggest that the Fe and Mn are precipitated inorganically, and that the microbial activity works as controlling factor on the redox condition of tank water. The observed phenomenon can explain the different behaviors of Fe and Mn in the natural aquifers.

Keywords: groundwater remediation, biofilm, microorganisms, ecosystem