Soil/Groundwater contamination measures based on an interaction between soils and chemicals

Hiroyuki Ishimori

Recently, an impact of soil/groundwater contamination on human health damage gradually becomes serious problems. Efficient measures are requested in order to prevent soil/groundwater from being contaminated, or in order to remedy a site that has already been contaminated. This study investigates (1) the barrier performance of a geosynthetic clay liner (GCL), which is a barrier material of landfill bottom liners, and (2) the performance evaluations of two technologies, pump-and-treat and permeable reactive barrier, for contaminated groundwater remediation.

The landfill wastes discharge toxic substances, therefore, geomembrane sheets or compacted clay liners are installed as bottom liners at waste containment facilities to prevent the groundwater from being contaminated. GCLs are factory-manufactured clay liners consisting of a thin layer of bentonite glued to a geomembrane or encased by geotextiles. GCLs are effective barrier materials alternated or combined with compacted clay layers, which are mainly used as the component of present bottom liner systems in waste containment facilities because of their relatively low cost, easy installation, and excellent barrier performance to water. But, electrolytic solutions such as waste leachates deteriorate the barrier performance of GCLs, because the bentonite has insufficient swelling against electrolytic solutions. As a first research theme, this thesis investigates the effects of chemical solutions on the barrier performance of GCLs, and discusses an effectiveness of treatment for a chemical resistance improvement of bentonite.

Toxic substances that have already infiltrated groundwater hazardously damage the life and health of people living nearby. Pump-and-treat remediation and permeable reactive barrier are remediation technologies to remove or treat the toxic substances in groundwater. Effectiveness of these technologies to a contaminated groundwater is significantly dependent on the aquifer structure, contaminant properties, and hydrogeologic conditions. Therefore, the performance of these remediation technologies must be evaluated based on migration characteristics of contaminants in groundwater. As a second research theme, this thesis quantitatively investigates the factors (the adsorption/desorption phenomenon of contaminants, clay lenses included in aquifer, and presence of non-aqueous phase liquid) affecting the performance of pump-and-treat remediation using seepage and advection-dispersion analysis. The performance of permeable reactive barrier is also evaluated based on contaminated groundwater migration; as a result, its effective design with cost-optimization is proposed.