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Application of Surgical Remediation to Complex Contaminated Sites in Taiwan

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Because of geological heterogeneity, it is easily to misestimate the distribution of pollutants and to predict the transportation of pollutants difficultly during the investigation and remediation of groundwater contamination. Furthermore, the injection of gas and remediation regents or biological species cannot effectively transport to pollutant area of complex geology, especially in low-permeability strata. Therefore, it is necessary to develop Surgical Remediation(SR) for some geological heterogeneity complex sites. The SR is to applying high resolution of investigation techniques to get more underground characteristic, such as 3D pollutant distribution, geological distribution and biochemical information, and to using better remediation transportation techniques to overcome geological heterogeneity. For example, remediation regents can be spread more widely to remediate pollutants in low-permeability strata.

A geological complex contaminated site in Taiwan, interbedded with sand and silty clay and its permeability reached 2˜3 orders of magnitudes, was studied in this research. The groundwater is highly contaminated with 1,2-Dichloroethane and Vinyl Chloride. (Many of them reached tens of ppm.) The pollutants have distributed over high-permeability strata (sand) and low-permeability strata (silty clay). We introduce the concept of SR, using Multi-Depth Pollutant Sampling Analysis, Multi-Depth Radon Analysis, Bacteria Flora Analysis, Multi-Depth Slug Tests, Well Log Analysis and Multi-Depth Flow Velocity and Direction of Single Well Test, to evaluate the 3D hydrogeology characteristic and the space-time variation of pollutants. We design appropriate injection pressure and flow according to hydraulic conductivity value range, pollution concentrations, and polluted depth and apply Double Packer Injection (DPI) to utilize multi-depth method injecting remediation regents (Japan Patented Biostimulation Reagents, EDC?, which can degrade high-concentration chlorinated contaminants effectively was chosen.) into the specific deep strata, and use the automated monitoring system developed by ourselves to confirm the interrelationship between the pressure of each injection depth and flow changes. The injection parameters are modified accordingly and instantly. Finally, we use the groundwater flow direction and perpendicular direction to evaluate the overall mass flux variation, and combine with novel geophysical, Cross-Hole Electrical Reisitivity Tomography (CHERT), to directly or indirectly evaluate remediation regents variation during transportation and the space-time improvement performance. This research proves that SR can be effectively investigated underground characteristic, and remediation regents can be efficiently transported within high-permeability strata and low-permeability strata to fit in with the expected direction, and pollution concentrations can be reduced significantly in few months to conform to the Control Standard.

Keywords: Geological heterogeneity, Surgical remediation, Double Packer Injection, Automated Monitoring Systems, Cross-Hole Electrical Reisitivity Tomography