

Three-dimensional analyze about the VOC's groundwater pollution of flow route and temporal change in Osaka

Hidenori Yoshioka^{1*}, Masuda Harue¹, Masumoto Shinji¹

¹Faculty of Science, Osaka City University

Since 1989, when the law of protection from water quality degradation was revised, VOCs (volatile organic compounds) have not been officially wasted in the environment. However, the VOCs, which were distributed before that time, still remain in the environment.

Osaka Prefectural Office has been managing the monitoring data of groundwater qualities as open information since 1990. In this study, distributions of tetrachloroethylene (PCE), trichloroethylene (TCE) and cis-1,2-dichloroethylene (DCE) were analyzed using estimation of three dimensional grid data to trace the temporal change of those distributions in the groundwater aquifers and recovery process from the anthropogenic pollution of groundwater in the Osaka basin. Data were treated using weighted mean method to produce the three-dimensional model of pollutant distribution. PCE is transformed through TCE to DCE via biochemical reductive dechlorination reaction in the aquifer.

Distributed areas of the three VOCs have extended with time since the monitoring started, and achieved the maximum during 1999-2000. And after that time, the polluted areas have been reduced. Takatsuki and the surrounding area and southern part of Kawachi area are where the VOCs' pollution is most prominent in the Osaka basin. In the former area, the polluted groundwater has migrated from the north to south at the riverside of Yodo with time. The highly polluted area has been reduced and occurred at the area close to the Yodo-river in 2005-2007. DCE concentration has increased at Hirakata, adjacent to Takatsuki, since it was found in 1999. PCE pollution has been prominent in the southern part of Kawachi, where the highly pollution was found at two areas. The polluted areas have been staying at the same area with time, indicating that the PCE has not been decomposed. The VOCs remain in the aquifer at >150m depths at Takatsuki and the surroundings and Kawachi areas. The level of contamination has been decreased since 2000, although TCE and biproduct DCE remains at high level in the both areas. Polluted groundwater aquifer is depressed beneath those areas, and pollutants tend to stay without flushing out.

Beneath the Uemachi-daichi, Pleistocene terrace at the center of Osaka Plain, VOCs pollution is rarely found. The major groundwater chemistry is Ca-HCO₃ type, indicating that the groundwater flows and flush out the VOCs.

The VOCs infiltrated vertically beneath the source areas into the groundwater, and dilution with flowing groundwater is the major recovering process from the pollution. When the aquifer has stagnant condition, VOCs remains more than decades without decomposition, suggesting that biogeochemical reaction rate to decompose the VOCs is too slow to reduce VOCs in the stagnant groundwater aquifer. Thus, appropriate use of groundwater must be a mitigation to recover from the VOCs pollution.

Keywords: volatile organic compound, reductive dechlorination, aquifer, weighted mean method, VRML