

Discussion on Source Identification in Groundwater Contaminated by Oil for more than 20 years near a Military Base

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Environmental forensic techniques for identifying groundwater contamination sources become essential. We applied several techniques including water chemistry, oil fingerprinting, and isotope analysis to investigate groundwater contamination sources in a site near a military base. In the studied site, oil leakage was first detected in a subway tunnel in July 2000, and high levels of BTEX and TPH were observed in groundwater nearby. In some wells BTEX is still detected at high concentrations since potential sources (e.g., gasoline station, oil tanks) within the military base are inaccessible. For the past 20 years, the municipality has prevented the dispersion of contaminants with pump and treatment and free-phase oil removal outside the military base and monitored the groundwater quality. In this study, we analyzed the concentrations of contaminants quarterly measured from March 2004 to October 2021 (n=65). In addition, groundwater samples were collected from 18 wells around the study area in September 2021 and August 2022 for water chemistry, hydrogen and carbon isotopes of BTEX, and oil fingerprinting. The factor analysis results using water chemistry indicated two major hydrogeological processes: (i) reducing environment by oil contamination. (ii) enhanced weathering due to BTEX degradation. Time series analysis showed that the concentrations of contaminants decreased in most wells over time, with higher decreasing rates in wells with higher initial concentrations. The oil type was revealed to be different depending on groundwater flow paths, implying different sources. However, the carbon isotopes of BTEX showed similar values in most wells ($\delta^{13}\text{C}$ of Benzene: -30.0 ~ -27.1‰), suggesting a same contamination source. The study result shows the difficulty in source identification in sites contaminated for a long time and with limited accessibility to potential sources. The study result will be combined with another technique, i.e., micropollutants for source identification. [Acknowledgement] The completion of this work was supported by the Korea Environment Industry & Technology Institute (KEITI) through the Subsurface Environment Management Research Project (No. 2021002440003).