Geochemical and Hydrologic Characterization to Identify the Source of Low Level Benzene in the Chicot Aquifer Groundwater

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ABSTRACT

A case study describing how multiple lines of geochemical evidence were used to identify the source of benzene detected in groundwater samples at concentrations above the federal maximum contaminant level (MCL) of 5 µg/L is presented. These wells are located in the vicinity of a municipal solid waste landfill, situated within a larger region that has been widely explored and developed for oil and gas resources. The affected monitoring wells were limited to two located over 1000 ft hydraulically upgradient of the waste placement area, with no benzene detections in samples from wells located downgradient of the waste. Although benzene concentrations were not correlated with increases in chloride concentrations, the site leachate had relatively low chloride concentrations (approximately 30 mg/L) and dissolved methane was present in the samples with benzene. The approach used for the evaluation was to evaluate groundwater data for the geochemical fingerprint of the three potential fluids that would transport the benzene from one of three potential sources of (a) landfill leachate, (b) landfill gas, and (c) field gas (unprocessed natural gas). Multiple forms of geochemical data from site leachate and landfill gas along with literature information on natural gas were used in combination with geochemical and hydrogeologic data for the affected groundwater to identify the most likely source of the detected benzene. The parameters considered included ^{14}C (Carbon-14), ^{13}C (Carbon-13) / Deuterium, Tritium, C_2 and C_3 alkanes, dissolved CO_2, and the direction of disequilibrium between groundwater and the gas phase. The results of all of the multiple evaluations were consistent with the natural gas as the source of the benzene, with no evidence of landfill gas or landfill leachate effects on the groundwater samples. The groundwater tritium levels were less than 2 Tritium Units, inconsistent with the landfill leachate tritium level of over 1200 Tritium Units, the methane ^{14}C content was 2 percent Modern Carbon (pMC), inconsistent with the landfill gas methane ^{14}C content of 125 pMC. The ^{13}C and deuterium of dissolved methane was consistent with thermogenic (natural gas) methane, the presence of dissolved C_2 and C_3 alkanes was consistent with natural gas and not landfill gas. The lack of a correlation between dissolved CO_2 and benzene was inconsistent with landfill gas but consistent with natural gas, and the direction of methane partitioning (water-to-gas) showed that the methane source was below the water table, consistent with natural gas.