

ABSTRACT

The aim of this project is to assess the potential for the bacterial degradation of tetrachloroethene (PCE) and trichloroethene (TCE) in the vadose zone of two vegetated slimes dams, Dam 2 and Dam 3/4. The focus is on the reductive dechlorination of PCE and TCE; however, the degradation of dichloroethene (DCE) and vinyl chloride (VC), which are the carcinogenic daughter products of reductive dechlorination, via oxidation, is also investigated. The spatial and temporal variability of the reductive dechlorination and oxidation potentials within the dams are measured, and the influence of the vegetation on this degradation is determined.

The spatial variation in the reductive dechlorination potential in the vadose zone is ascertained by modifying a points system originally devised for the groundwater. The resultant points system includes the water content, redox potential, pH, temperature, the carbon source (including the measurement of soil organic matter and BTEX compounds) and the pollutants and daughter products, all of which are measured at various sites and depths on each dam. The spatial variation in the potential for oxidation in the vadose zone is determined based on the redox potential measurements. To establish the change in the potential for reductive dechlorination and oxidation between seasons, temporal measurements of redox potential are made using permanently installed redox electrodes. Since the dams have differing vegetation maturities, the effect of vegetation on the potential for bacterial degradation is ascertained by comparing the potentials for reductive dechlorination and oxidation between each dam.

The most important parameters in determining the potential for reductive dechlorination and oxidation in the vadose zone at the dams are the redox potential and the quantity of BTEX compounds. Reductive dechlorination is dominant within the measurement profile at Dam 3/4 due to a higher distribution of BTEX compounds and a lower redox potential, while at Dam 2 oxidation is dominant due to a lower distribution of BTEX compounds and a higher redox potential within the measurement profile. This is attributed to a higher vegetation maturity on Dam 2 compared to Dam 3/4. The temporal measurements of redox potential indicate that the seasonal fluctuation in degradation mechanisms is unlikely, except at isolated depths near the base of the measurement profile at Dam 2. Due to the role of vegetation in promoting

oxidation, in the past the conditions in Dam 2 would likely have resembled those currently at Dam 3/4, and Dam 2 is an indication of what Dam 3/4 is likely to be like in the future. Consequently, in the future Dam 3/4 is likely to promote oxidation over more of the profile which will lead to the degradation of DCE and VC. However, before oxidation commences, reductive dechlorination should be promoted at both dams until the PCE and TCE is degraded to acceptable limits, to prevent their continued presence.