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Origin and fate of vinyl chloride in a groundwater plume

R. Aravena (1), D. Hunkeler (2), A. Gargini (3), M. Pasini (3), S. Shoukar (1), Y. Abe (2)

(1) University of Waterloo, Waterloo, Canada, (2) University of Neuchâtel, Neuchâtel, Switzerland, (3) University of Ferrara, Ferrara, Italy

Chlorinated ethenes are one of the most common contaminants found in groundwater. The presence of VC in groundwater is commonly considered as a byproduct of reductive dechlorination of chlorinated ethenes. However, at some sites vinyl chloride may also be present as primary contaminant. The goal of the study was to evaluate if stable carbon and chlorine isotopes can be used to identify vinyl chloride as primary contaminant and to trace the fate of the compound in a groundwater plume. The study site is a sandy aquifer underlying the densely urbanized Pontelagoscuro northern part of the city of Ferrara, Italy. A VC plume with absence of other chlorinated ethenes was detected in the aquifer likely linked to infiltration of residues from a PVC production facility.

The VC plume was delineated using monitoring wells and profiling with a direct-push rig. VC concentrations of up to 11 mg/L were found in some part of the plume. Carbon isotope analysis of the VC revealed very depleted δ^{13}C values between -61 and –73 per mille in wells with the highest concentration. The depleted δ^{13}C value could be linked to the VC production processes or due to isotope fractionation associated with the polymerization process. The very depleted isotope values may serve as a fingerprint to elucidate the presence of VC as primary contaminant for other sites with similar wastes. Downgradient of the source along the groundwater flow system, a substantial shift of the carbon isotope ratios was observed suggesting transformation of the VC. The presence of CH_4, C_2H_4 and C_2H_6 suggest the plume is under anaerobic conditions. Currently, combined carbon and chlorine isotope analysis of VC and carbon isotope analysis on CH_4, C_2H_4 and C_2H_6 is been carried out. The dual isotope approach in conjunction with characterization of redox conditions should provide in-

sight into the pathway of VC degradation, as oxidative and reductive transformation are expected to lead to different relative shifts for the two isotopes. Once the pathway of VC degradation is identified, biodegradation rates will be estimated based on shifts in isotope ratios and groundwater flow velocities, which will be use to predict the future evolution of the VC plume in the aquifer.