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Combining Bio-Molecular and Isotopic Tools to Determine the Fate of Halogenated Compounds in Polluted Groundwater

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Abstract : Brominated flame retardants are widespread pollutants, and are known to be toxic, carcinogenic, endocrinic disrupting as well as recalcitrant. The industrial complex Neot Hovav, in the Northern Negev, Israel, is situated above a fractured chalk aquitard, which is polluted by a wide variety of halogenated organic compounds. Two of the abundant pollutants found in the site are Dibromoneopentyl-glycol (DBNPG) and tribromoneopentyl-alcohol (TBNPA). Due to the elusive nature of the groundwater flow, it is difficult to connect between the spatial changes in contaminant concentrations to degradation. In this study, we attempt to determine whether these compounds are biodegraded in the groundwater, and to gain a better understanding concerning the bacterial community in the groundwater. This was achieved through the application of compound-specific isotope analysis (CSIA) of carbon (13^C/12^C) and bromine (81^Br/79^Br), and new-generation MiSeq pyrosequencing. The sampled boreholes were distributed among three main areas of the industrial complex: around the production plant of TBNPA and DBNPG; along the Hovav Wadi (small ephemeral stream) which crosses and drains the industrial complex; and downstream to the industrial area. TBNPA and DBNPG are found in all three areas, with no clear connection to the proximity of the borehole to the production plant. Initial isotopic data of TBNPA from boreholes in the area surrounding the production plant, reveal no changes in the carbon and bromine isotopic values. When observing the microbial groundwater community, the dominant phylum is Proteobacteria. Known anaerobic dehalogenating bacteria such as Dehalococcoides from the Chloroflexi phylum have also been detected. A statistical comparison of the groundwater microbial diversity using a multi-variant ordination of non-metric multidimensional scaling (NMDS) reveals three main clusters in accordance to spatial location in the industrial complex: all the boreholes sampled adjacent to the production plant cluster together and separately from the Wadi Hovav boreholes cluster and the downstream to the industrial area borehole cluster. This work provides the basis for the development and implication of an isotopic fractionation based tool for assessing the biodegradation of brominated organic compounds in contaminated environments, and a novel attempt to characterize the spatial microbial diversity in the contaminated site.

Keywords : biodegradation, brominated flame retardants, groundwater, isotopic fractionation, microbial diversity
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