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16. Abstract

This research addresses the role of volatile organic compounds (VOC) as indicators of groundwater pollution by hazardous wastes. These compounds consist primarily of hydrocarbons, *e.g.*, benzene, and chlorinated hydrocarbons, *e.g.*, trichloroethylene, that are neutral, only sparingly soluble in water, and readily evaporated from water. Because of their lack of chemical reactivity under mild conditions and their ready volatilization, VOC are particularly difficult to determine in groundwater, and emphasis has been placed on that aspect of the research. Chromatography, in some cases combined with mass spectrometry, has been used as the analytical method of choice. Attention has been given to sample preservation and consideration to the possibility of on-site monitoring.

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MONITORING VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER: INDICATORS OF ORGANIC HAZARDOUS WASTES POLLUTION IN MISSOURI

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U. S. Department of the Interior

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2. ABSTRACT

This research addresses the role of volatile organic compounds (VOC) as indicators of groundwater pollution by hazardous wastes. These compounds consist primarily of hydrocarbons, *e.g.*, benzene, and chlorinated hydrocarbons, *e.g.*, trichloroethylene that are neutral, only sparingly soluble in water, and readily evaporated from water. Because of their lack of chemical reactivity under mild conditions and their ready volatilization, VOC are particularly difficult to determine in groundwater, and emphasis has been placed on that aspect of the research. Chromatography, in some cases combined with mass spectrometry, has been used as the analytical method of choice. Attention has been given to sample preservation and consideration to the possibility of on-site monitoring.

3. Statement of purpose and objectives of the project

The purpose of this research is to explore the uses of the monitoring and analysis of VOC as indicators of hazardous waste pollutants of groundwater. The accurate determination of VOC in groundwater is especially difficult because of loss of volatile analyte from the sample; because of levels of VOC that are generally quite low, yet indicative of substantial pollution; and because of possibly severe interference from ubiquitious naturally occurring methane in groundwater.

The two major objectives of the research are the following:

1. Development of sampling and analysis methodologies proven to give accurate results for VOC in groundwater.
2. Applications of the methods developed to the possible correlation of the finding of VOC in groundwater with the proximity of hazardous waste disposal sites.

4. Discussions of related research or activities, of methods and procedures of principal findings and their significance

Prior to the time that this research was undertaken, a systematic search of the literature did not show any completed investigations or investigations in progress devoted specifically to the correlation of VOC in groundwater with the proximity of hazardous waste disposal. A work was found dealing with a survey of VOC in groundwater supplies (1). The detection of trace organics in well water near a solid waste landfill was addressed (2), but without emphasis specifically on VOC. One field study was found dealing with the behavior of organic compounds during infiltration of river water to groundwater (3). Three papers were useful for their analytical aspects (4,5,6).

As suspected, the research showed severe difficulties in the retention of VOC in groundwater samples. Sample loss during storage and transfer is substantial. Although not proven yet, it is presumed that sample loss in transferring sample from the groundwater source to the sample container must be very substantial.

The actual laboratory determination of VOC in a sample that has been introduced into a gas chromatograph is relatively straightforward and, with modern instrumentation, quite accurate and with low detection limits. For hydrocarbons the most sensitive and linear detector is the flame ionization detector (FID), with a degree of selectivity introduced for aromatic compounds with the photoionization detector (PID). Organochlorine compounds are detected at very low levels by the electron capture detector. For all species (though at greater cost and complexity) compound specificity is obtained with a mass spectrophotometric (MS) detector.

An original concern at the beginning of the research was the possibility of large concentrations of naturally-occurring and pollutant methane (from the anaerobic decay of biodegradable waste organic matter such as municipal refuse) completely overwhelming separation and detection systems for other species. This problem does not exist for organochlorine compounds because of the use of the ECD, which does not respond to methane. Even with the use of the FID, however, columns were devised that enabled detection of very low levels of low-molecular-weight hydrocarbons (except for ethane) in water at levels of methane 3 to 4 orders of magnitude higher than the analyte hydrocarbon. Probably the sparging of VOC by methane and CO_2 from the water sample and from the groundwater before it is sampled is an appreciably greater problem.

The research is continuing as part of two graduate student thesis projects to more closely determine the possible correlation of VOC in groundwater with hazardous waste contamination. Results of this research will be available when the thesis projects are completed. If a correlation can be established, it is probable that monitoring VOC can serve as a means of "early warning" of hazardous waste pollution of groundwater and as a means of locating hazardous waste sources that pollute water.

5. Conclusions

VOC are significant constitutents of polluted groundwater. Their monitoring holds considerable potential for tracing hazardous waste pollution sources. The determination of VOC in groundwater offers few major problems; obtaining and maintaining representative samples is much more of a challenge. Additional research must be done to correlate the occurrence of VOC in groundwater with hazardous waste pollution.

6. Literature citations

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