

**American Association for the Advancement of Science**  
Science serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

**Publisher:** Richard S. Nicholson  
**Editor:** Daniel E. Koshland, Jr.  
**News Editor:** Ellis Rubinstein  
**Managing Editor:** Patricia A. Morgan  
**Deputy Editors:** Philip H. Abelson (*Engineering and Applied Sciences*); John I. Brauman (*Physical Sciences*)

#### EDITORIAL STAFF

**Assistant Managing Editor:** Monica M. Bradford  
**Senior Editors:** Eleanore Butz, Martha Coleman, Barbara Jasny, Katrina L. Kelner, Phillip D. Szurmi, David F. Voss  
**Associate Editors:** Keith W. Brocklehurst, R. Brooks Hanson, Pamela J. Hines, Linda J. Miller  
**Letters Editor:** Christine Gilbert  
**Book Reviews:** Katherine Livingstone, *editor*  
**Contributing Editor:** Lawrence I. Grossman  
**Chief Production Editor:** Ellen E. Murphy  
**Editing Department:** Lois Schmitt, *head*; Mary McDaniel, Patricia L. Moe, Barbara P. Ordway  
**Copy Desk:** Joi S. Granger, Margaret E. Gray, MaryBeth Shurtle, Beverly Shields  
**Production Manager:** James Landry  
**Assistant Production Manager:** Kathleen C. Fishback  
**Art Director:** Yolanda M. Rook  
**Graphics and Production:** Holly Bishop, Julie Cherry, Catherine S. Siskos  
**Systems Analyst:** William Carter

#### NEWS STAFF

**Correspondent-at-Large:** Barbara J. Culliton  
**Deputy News Editors:** John M. Benditt, Jean Marx, Colin Norman  
**News and Comment/Research News:** Mark H. Crawford, Constance Holden, Richard A. Kerr, Elliot Marshall, Joseph Palca, Robert Pool, Leslie Roberts, Marjorie Sun, M. Mitchell Waldrop  
**European Correspondent:** Jeremy Cherfas  
**West Coast Correspondent:** Marcia Barinaga

#### BUSINESS STAFF

**Circulation Director:** John G. Colson  
**Fulfillment Manager:** Marlene Zendell  
**Business Staff Manager:** Deborah Rivera-Wienhold  
**Single Copies Manager:** Ann Ragland  
**Classified Advertising Supervisor:** Amie Charlene King

#### ADVERTISING REPRESENTATIVES

**Director:** Earl J. Scherago  
**Traffic Manager:** Donna Rivera  
**Traffic Manager (Recruitment):** Gwen Carter  
**Advertising Sales Manager:** Richard L. Charles  
**Marketing Manager:** Herbert L. Burkund  
**Employment Sales Manager:** Edward C. Keller  
**Sales:** New York, NY 10036; J. Kevin Henebry, 1515 Broadway (212-730-1050); Scotch Plains, NJ 07076; C. Richard Callis, 12 Unami Lane (201-889-4873); Chicago, IL 60914; Jack Ryan, 525 W. Higgins Rd. (312-885-8675); San Jose, CA 95112; Bob Brindley, 310 S. 16th St. (408-998-4690); Dorset, VT 05251; Fred W. Dieffenbach, Kent Hill Rd. (802-867-5581); Damascus, MD 20872; Rick Sommer, 11318 Kings Valley Dr. (301-972-9270); U.K., Europe: Nick Jones, +44(0647)52918; Telex 42513; FAX (0647) 52053.

**Information for contributors** appears on page XI of the 22 December 1989 issue. Editorial correspondence, including requests for permission to reprint and reprint orders, should be sent to 1333 H Street, NW, Washington, DC 20005. Telephone: 202-326-6500. **Advertising correspondence** should be sent to Tenth Floor, 1515 Broadway, New York, NY 10036. Telephone 212-730-1050 or WU Telex 968082 SCHERAGO, or FAX 212-382-3725.

## Volatile Contaminants of Drinking Water

**P**ublic concern about possible contamination of water supplies is a fact of life. It is a fear of the unknown that may be overdrawn, but a fear that could lead to a waste of hundreds of billions of dollars. Development of effective means of reducing water contamination would ease concerns while minimizing costs of remediation. This country is only in the beginning stages of conducting the necessary research and development, but progress is being made, particularly in delineating the problems and in conducting research.

The volatile contaminants in a large number of water supplies have been analyzed and means of destroying them are being discovered. The most ubiquitous class of pollutants is chlorinated hydrocarbons, notably TCE (trichlorethylene,  $\text{CHCl}=\text{CCl}_2$ ) and its degradation products. TCE is one of the leading contaminants found in ground water and is the chemical most often detected at Superfund sites. Large quantities of it were widely used for decades in degreasing, and wastes were carelessly disposed of.

The physical properties of TCE have contributed to its widespread occurrence. It has a boiling point of 88°C and a density of about 1.46. Its solubility in water is about 1000 parts per million (ppm). Thus when dirty fluids were conveyed to waste dumps, part of the TCE evaporated, but much of it moved downward; some ultimately encountered ground water. Ground water in aquifers travels at rates as low as a meter per year and as high as meters per day. Plumes of contaminated water that extend 10 km from sources have been noted.

In pure water at pH 7 and ambient temperatures, highly chlorinated hydrocarbons are remarkably stable, with half-lives as long as a million years or more. However, under strongly reducing circumstances, some of the chlorine is removed and the resultant products are more subject to hydrolysis and later to aerobic metabolism.

Because of its widespread occurrence, TCE has been and is the object of considerable research activity. Work by Perry L. McCarty and colleagues at Stanford several years ago showed that under methanogenic (reducing) conditions TCE was almost completely destroyed in a few days. At ambient temperatures in the dark TCE reacts only slowly with oxygen and is ordinarily not subject to attacks by microorganisms. However, some organisms that can employ methane, propane, or toluene with oxygen as sole energy and carbon sources can co-metabolize TCE. This discovery has led to research designed to form the basis for patents on microorganisms to be used in TCE bioremediation. However, many knowledgeable microbiologists suggest that mixed cultures already adapted to the local circumstances will be quite effective. Organisms that can co-metabolize TCE have been found in many places. In one instance a large and active community of microorganisms was found in an aquifer 50 to 65 m beneath the soil surface.

In situ bioremediation of TCE-containing water is apparently limited to fluids containing less than about 100 ppm of TCE. Higher concentrations seem to be toxic. Nevertheless, this leaves enormous volumes of water to which biotreatment might be applicable.

Some fraction of the TCE that has been placed at waste sites remains there in rusting drums that should be removed at once. An additional approach is to transfer contents of the waste site to an incinerator and subject it to high temperatures. This is probably the procedure of choice when concentrations of contaminating waste are high. However, it is expensive, and the cost per unit of waste destroyed can be excessive if the wastes are dilute. Another technique is to bring contaminated water to the surface and to treat it, usually by air stripping. This transfers the contaminant into the atmosphere. One possibility that has not received much attention is a combination of moderate heat, moisture, and oxygen applied to the waste site. One report\* states that when a solution of TCE (1 ppm) was enclosed in the dark in a vessel containing air at a temperature of 25°C, the half-life of the TCE was less than a year. At temperatures near 100°C the reaction should proceed in about a day.

Each waste site is different, and each aquifer is different. No single cure-all exists. But a continued systematic approach involving earth scientists, chemical engineers, and microbiologists will surely lead to more effective remediation than has hitherto been achieved.

—PHILIP H. ABELSON

\*W. L. Dilling, N. B. Tefertiller, G. J. Kallos, *Environ. Sci. Technol.* **9**, 833 (1975).

## Volatile contaminants of drinking water

PH Abelson

*Science* **247** (4939), 141.  
DOI: 10.1126/science.2294597

### ARTICLE TOOLS

<http://science.sciencemag.org/content/247/4939/141>

### REFERENCES

This article cites 1 articles, 0 of which you can access for free  
<http://science.sciencemag.org/content/247/4939/141#BIBL>

### PERMISSIONS

<http://www.sciencemag.org/help/reprints-and-permissions>

Use of this article is subject to the [Terms of Service](#)

---

*Science* (print ISSN 0036-8075; online ISSN 1095-9203) is published by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. The title *Science* is a registered trademark of AAAS.

Copyright © 1990 The Authors, some rights reserved; exclusive licensee American Association for the Advancement of Science. No claim to original U.S. Government Works.