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Bart Davidson

University of Kentucky, bdauidson@uky.edu

R. Stephen Fisher

University of Kentucky

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Groundwater Quality in Kentucky: Mercury

Bart Davidson and R. Stephen Fisher
Kentucky Geological Survey

Introduction

Mercury is a naturally occurring metal that occurs in trace amounts in water, soils, and rocks. Elemental mercury is a liquid that occurs in some ore deposits; it may also be concentrated around hot springs. Currently, about 50 percent of mercury use is for electrical products such as dry-cell batteries, fluorescent lights, switches, and other control equipment. Mercury is also used in the electrolytic preparation of chlorine gas and caustic soda, and in paint manufacture and pesticide production (U.S. Environmental Protection Agency, 2002). In the past, significant amounts of mercury were used in thermometers and pressure gauges.

Mercury is sufficiently volatile that it is released to the atmosphere through natural degassing of the earth's crust. Other sources of mercury are combustion of fossil fuels, sewage discharge, metal-refining operations, cement manufacture, municipal landfills, and chemical industries (U.S. Environmental Protection Agency, 2002). Coal-fired power plants are the largest man-made source of atmospheric mercury emissions in the United States; other significant sources are industrial boilers, burning municipal hazardous waste, and chlorine production (U.S. Environmental Protection Agency, 2004).

The health hazards of mercury exposure depend on the form of mercury to which a person is exposed (U.S. Environmental Protection Agency, 2003). Elemental mercury is relatively inert, although it gives off hazardous fumes at room temperature and can be adsorbed through the skin. If swallowed, it is not readily adsorbed by the stomach, and will usually pass through the body without harm. Inorganic mercury compounds such as mercuric chloride can be inhaled or adsorbed through the skin, and can cause severe kidney damage (New Jersey State Department of Health and Senior Services, 1998). Inorganic mercury compounds can also be ingested through food grown in mercury-contaminated soils.

The greatest health hazards result when anaerobic bacteria convert elemental or inorganic mercury to organic methylmercury. Methylmercury is highly soluble in water and is concentrated in fish and shellfish, where it can reach concentrations of several thousand parts per million. People are exposed to mercury primarily by eating fish that have been contaminated from improper disposal of industrial waste and chemicals.

Chronic mercury poisoning can result in mood swings and severe nervous disorders. Both short- and long-term exposure to high mercury levels has been found to cause kidney damage (U.S. Environmental Protection Agency, 2002). These health effects have caused the U.S. Environmental Protection Agency to set the maximum contaminant level (MCL) for mercury in drinking water at 0.002 mg/L.

Concentrations in Groundwater Data Sources

Data for this report were compiled from the Kentucky Groundwater Data Repository, maintained by the Kentucky Geological Survey. The repository was established in 1990 to archive and disseminate groundwater data collected by various agencies in Kentucky. The main data sources for the repository are the Kentucky Division of Water, the Kentucky Geological Survey, the U.S. Geological Survey, the National Uranium Resource Evaluation Program, and the U.S. Environmental Protection Agency.

The database contained 3,506 analyses of mercury from 872 wells and springs throughout Kentucky as of June 2004. Analytical results from known or suspected contaminated sites, including samples collected for the Resource Conservation and Recovery Act and the Solid Waste and Underground Storage Tank regulatory programs, were excluded from the data set. Many analytical results were reported only as being below a detection limit. Detection limits ranged from 0.000004 to 0.002 mg/L. Results are summarized in Table 1.

Physiographic Region	No. of Values	No. of Sites	No. of Sites Above Detection	No. of Sites Above MCL
Inner Bluegrass	296	41	1	0
Outer Bluegrass	432	120	7	0
Knobs	159	45	1	0
Eastern Ky. Coal Field	758	207	14	0
Western Ky. Coal Field	403	96	8	0
Jackson Purchase	424	143	34	4
Eastern Pennyroyal	128	39	2	0
Western Pennyroyal	906	181	12	2

Table 1. Summary of mercury concentrations.

The database contained 2,112 analyses of total mercury (unfiltered groundwater) and 1,394 analyses of dissolved mercury (filtered groundwater). No distinction was made in this report between total and dissolved mercury in groundwater. MCL values are based on total concentrations. In cases where both total and dissolved values were measured at the same site, the differences between the two values were usually negligible. Therefore, both dissolved and total values were included in the data set to improve statewide coverage.

Regional Variations in Mercury Concentrations

This map shows sites where mercury has been measured; different symbols show concentration ranges. Sites that have been sampled on multiple occasions may have more than one symbol, and symbols may overlap if the sites are close to each other.

Data reported as not detected indicate that mercury was tested for, but not found. Approximately 99 percent of all mercury measurements were less than or equal to the MCL of 0.002 mg/L (Figure 1). Only six sites yielded mercury concentrations greater than 0.002 mg/L. The median value for mercury in each of Kentucky's physiographic regions is less than a detection limit of 0.00005 mg/L, well below the MCL.

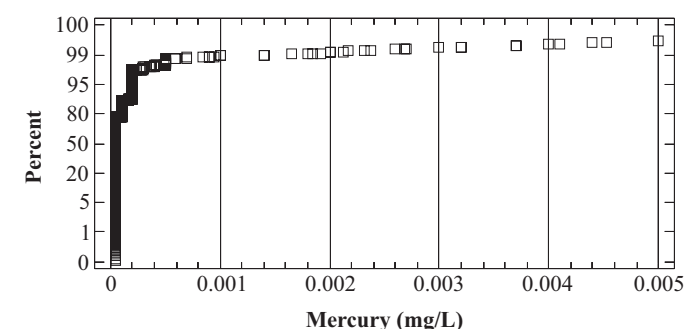


Figure 1. Cumulative percentage plot of mercury values (MCL = 0.002 mg/L).

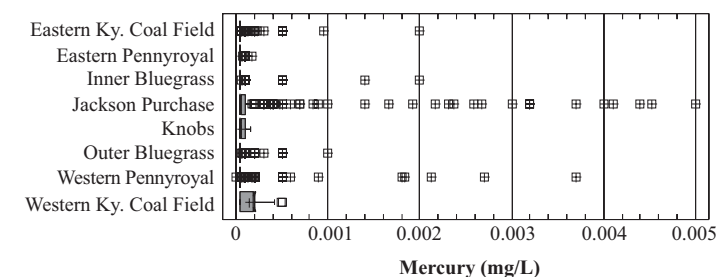


Figure 2. Box plots of mercury values for each of the major physiographic region (MCL = 0.002 mg/L)s.

Figure 2 summarizes the mercury measurements for each physiographic region. In this figure, boxes enclose the central 50 percent of the values. The median value is shown by vertical line through the box, and lines extend from each edge of the box for a distance of 1.5 times the mercury range represented by the central box. Values beyond this range are shown as individual squares. The physiographic regions with the lowest range of values were the Knobs, the Eastern Pennyroyal and Western Kentucky Coal Field.

Water-Quality Concerns

Mercury in Kentucky groundwater generally does not exceed the MCL. Concentrations of mercury that do exceed the MCL are spread across the state, and do not appear to be directly related to bedrock lithology.

These findings should be viewed as general patterns. Individual wells or springs should be tested for the occurrence of mercury and other potential contaminants before being used as drinking-water supplies. Citizens with concerns about the quality of water in private wells or springs should contact their local health department or the Groundwater Branch of the Kentucky Division of Water (a division of the Kentucky Natural Resources and Environmental Protection Cabinet). The Groundwater Branch can provide literature on maintenance of private wells and springs and information on sampling for water-quality analysis.

The Kentucky Interagency Groundwater Monitoring Network

This publication is a product of the Kentucky Interagency Groundwater Monitoring Network, which was established in 1998 by legislation (KRS 151.625) to collect groundwater quality data, characterize groundwater resources, and distribute the resulting information. The network is assisted by an Interagency Technical Advisory Committee on Groundwater (ITAC), which was also created by statute (KRS 151.629). Additional information and member agencies can be found at <http://www.uky.edu/KGS/water/gnet/gnet.htm>.

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Kentucky Geological Survey
University of Kentucky
For further information, contact:
Technology Transfer Officer
Kentucky Geological Survey
228 Mining & Mineral Resources Building
University of Kentucky
Lexington, KY 40506-0107
Phone: (859) 257-5500
www.uky.edu/kgs

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MERCURY CONCENTRATIONS IN WELLS AND SPRINGS IN KENTUCKY

EXPLANATION

Physiographic areas

- Eastern and Western Kentucky Coal Fields
- Inner Bluegrass
- Outer Bluegrass
- The Knobs
- Eastern Pennyroyal
- Western Pennyroyal
- Alluvium or glacial deposits
- Jackson Purchase
- River basin boundary
- Green River basin name

Mercury concentrations

- ▲ Greater than .002 mg/L
- Less than or equal to .002 mg/L
- Not detected

Data from Kentucky Groundwater Data Repository, July 2004

