Distribution of Arsenic in Ground Water and Surface Water, Cook Inlet Basin, Alaska

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Abstract

In 1999, the National Academy of Sciences concluded that the current standard of 50 micrograms per liter (µg/L) does not sufficiently protect public health, and recently, the Federal Government revised the maximum contaminant level to 10 µg/L. This new standard will become effective in January 2006 and applies to public water-supply systems.

Studies of ground water in the Cook Inlet Basin by the U.S. Geological Survey (USGS), Alaska Department of Environmental Conservation, Alaska Department of Natural Resources, and Municipality of Anchorage indicate that some domestic and public-supply wells yield water containing concentrations of arsenic that exceed the new 10-µg/L standard. High concentrations of arsenic have been observed in ground water in the Municipality of Anchorage and in the Kenai Peninsula and Matanuska–Susitna Boroughs. Water from 30 percent of the 220 wells sampled for arsenic in the Cook Inlet area by the USGS from 1969 to 1999 had an arsenic concentration of 10 µg/L or higher. The highest concentration in water sampled by the USGS was 150 µg/L. Samples of drinking water collected for the Alaska Department of Environmental Conservation indicate high concentrations of arsenic in some public-supply water; at least one sample from each of more than 60 public-water systems in south-central Alaska reportedly had an arsenic concentration greater than 10 µg/L. In contrast, samples of water from streams in the Cook Inlet Basin had very low concentrations of dissolved arsenic. Of 58 surface-water sites sampled by the USGS, 50 had concentrations that were at or less than the 1-µg/L detection level.

Introduction

Long-term exposure to high concentrations of arsenic in drinking water and food has been linked to bladder, lung, and skin cancer in humans (National Research Council, 1999). In 1999, the National Academy of Sciences concluded that the current standard of 50 µg/L does not sufficiently protect public health. In October 2001, the Federal Government revised the maximum contaminant level (MCL) to 10 µg/L (U.S. Environmental Protection Agency, 2001), which will become effective in January 2006. MCLs only apply for public-water supplies but can provide a guide for water users in homes that have private supply wells.

Arsenic is a naturally occurring element in the Earth's crust and is commonly adsorbed to or coprecipitated with iron oxide minerals; adsorbed to clay-mineral surfaces; associated with sulfide minerals or organic carbon; or present in some types of volcanic rocks. Analyses by the U.S. Geological Survey (USGS) of trace elements in streambed sediments sampled for the National Uranium Resource Evaluation and National Water-Quality Assessment programs and studies in cooperation with the National Park Service indicate that concentrations of arsenic in the Cook Inlet Basin appear to be naturally high (Frenzel, 2000). Concentrations of arsenic in streambed sediments at 14 sites sampled for NAWQA and National Park Service studies ranged from 5.2 to 44 µg/g (dry weight); 13 of these 14 samples had concentrations exceeding the national median value of 6.35 µg/g. The natural dissolving or desorbing of arsenic from soils and aquifer materials may introduce arsenic into the area's water.

The addition of arsenic to water in the Cook Inlet Basin by humans is minimal. More than 90 percent of the total use of arsenic in the United States is as a preservative in wood products. The total contribution of arsenic from treated wood to water in the Cook Inlet Basin probably is extremely small compared to the large amount of arsenic that occurs naturally in the area's rocks and soils.

Ground Water

Many domestic and public-supply wells throughout the Cook Inlet Basin yield water having arsenic concentrations greater than the new MCL of 10 μg/L, but concentrations vary widely, even at a local scale (fig. 1). The only way to be certain of the arsenic concentration in water supplied by a given well is to have the water tested. The health effects of arsenic depend on the concentration of arsenic in drinking water and the amount of water consumed.

Concentrations of arsenic in water supplied to the public are commonly greater than 10 μg/L. Water sampled from more than 60 of the 448 public-water systems in south-central Alaska had arsenic concentrations greater than 10 μg/L (Keven Kleweno, Alaska Department of Environmental Conservation, written commun., 2000). Some were from wells supplying water to subdivisions, apartments, trailer courts, restaurants, day-care centers, and schools. High arsenic concentrations were found in water from wells in the Municipality of Anchorage and the Matanuska–Susitna and Kenai Peninsula Boroughs.

Because of concerns about high levels of arsenic in ground water near Sand Lake in the western part of Anchorage, the Municipality of Anchorage Department of Health and Human Services sampled water from 25 domestic wells. Water samples were collected between December 2000 and March 2001 from faucets inside houses; many were collected after the water passes through water softeners and(or) filters. Concentrations were less than the detection level (1 μg/L) at 3 of the 25 sites. Tap water from 19 of the 25 residences had concentrations of arsenic greater than 10 μg/L; of those, 13 were greater than 24 μg/L, and 3 exceeded the current MCL of 50 μg/L. The highest concentration was 89 μg/L.

Analyses by the USGS and Alaska Department of Natural Resources indicate that concentrations of arsenic in ground water vary widely, even among wells within a single residential subdivision, possibly owing to local differences in geology, geochemistry, and aquifer conditions. Of the 220 wells sampled by the USGS from 1969 through 1999, about one-third had water containing dissolved arsenic at concentrations of 1 μg/L or less, about 30 percent had concentrations greater than 10 μg/L, and about 5 percent had concentrations greater than 50 μg/L. The highest dissolved-arsenic concentration from the USGS samples, 150 μg/L, was for water from a well on the west side of Cook Inlet. Most ground-water samples that contained high arsenic concentrations were from chemically reduced environments.

Concentrations of dissolved arsenic greater than 50 μg/L were observed in water from several wells on the Kenai Peninsula (in Nikiski, Kenai, Soldotna, and Sterling) by the USGS (Glass, 1996, 1999, 2001) and the Alaska Department of Natural Resources (Maurer, 1993; Maurer and Ireland, 1994). Concentrations also could be high elsewhere, but sampling and reporting of water-quality conditions have not been done for many locations where ground water is used for water supplies. For example, few analyses of arsenic are currently available for the hillside areas of Homer, south Anchorage, and Eagle River; in these upslope neighborhoods, thousands of homes have individual wells for their water supply.

Surface water

Although arsenic in surface water is derived primarily from the natural weathering of soils and rocks and from the discharge of ground water, detectable arsenic concentrations are uncommon in Cook Inlet Basin streams. Analyses of water samples collected by the USGS from 1969 through 2000 are available from several sites in the basin. These analyses include both dissolved arsenic (for which water samples are passed through a 0.45-micrometer filter) and total arsenic (for which water samples are left unfiltered). Of the 58 surface-water sites having dissolved-arsenic analyses, 50 had concentrations that were at or less than the 1-μg/L detection level. The highest dissolved-arsenic concentrations were observed at Fritz Creek near Homer (3 μg/L) and Swanson River near Kenai (9 μg/L). Concentrations of arsenic in the unfiltered samples generally were higher than in the filtered samples, probably because of the arsenic associated with suspended sediment particles. The three sites having the highest total-arsenic concentrations were Knik River near Palmer (14 μg/L), Maclaren River near Paxson (18 μg/L), and a canal on the east side of Sand Lake in Anchorage (24 μg/L).

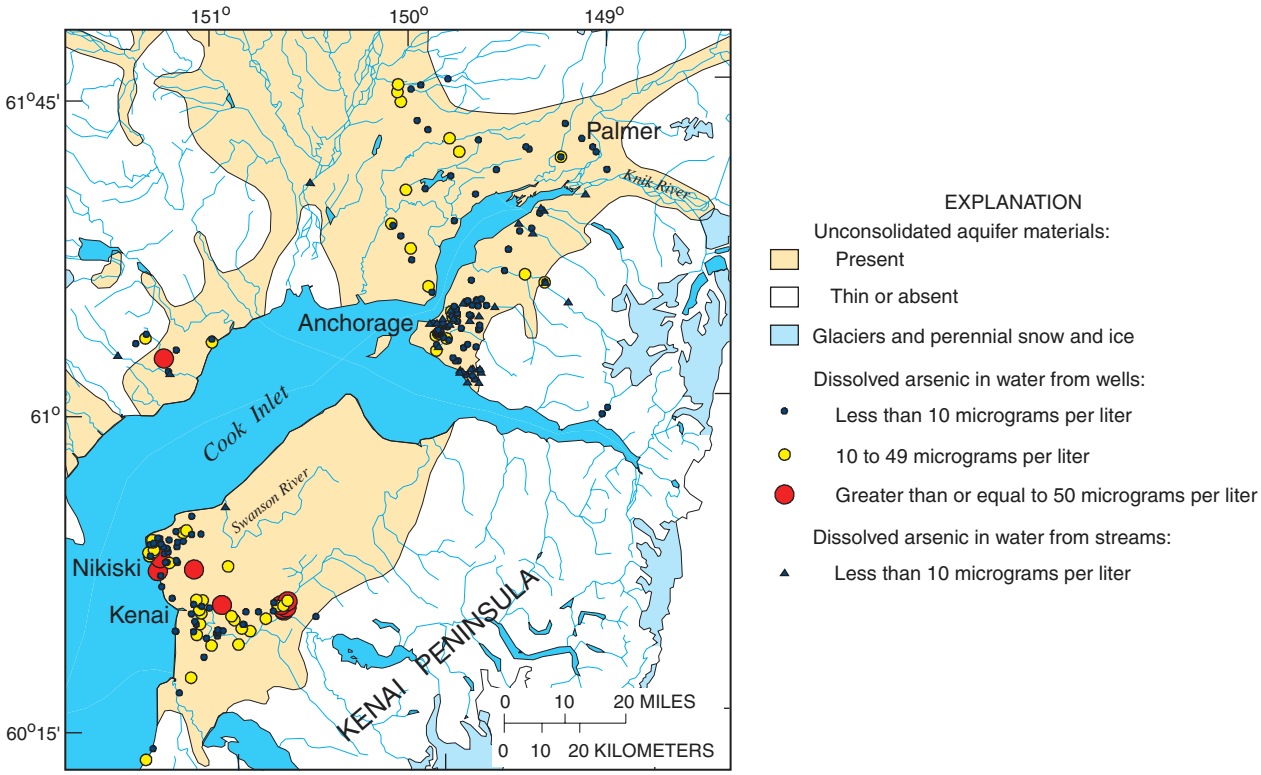

Figure 1. Spatial distribution of dissolved arsenic in selected wells and streams sampled by the U.S. Geological Survey.

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