Naturally Occurring Arsenic in Interior Alaska Groundwater

Alaska Division of Geological & Geophysical Surveys

33
As
Arsenic
74.922

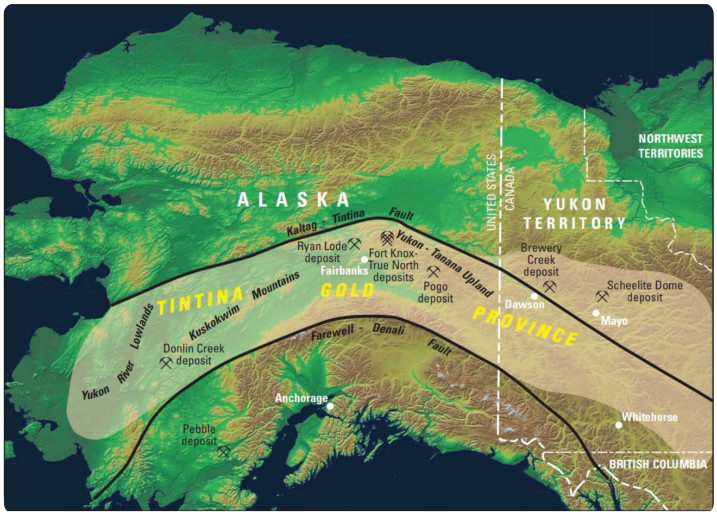
Arsenic (chemical symbol As) is a toxic metal that occurs naturally in the Earth's crust. Depending on chemical factors such as acidity and oxidation of an area's water, arsenic that is bound up in the crystal structure of minerals may be liberated and make its way into drinking water and soils. **Levels of arsenic greater than 10 parts per billion (ppb), the current EPA drinking water standard, have been documented in many areas around Fairbanks, notably on Ester and Murphy domes, and in the Steele Creek and Goldstream neighborhoods.** In some Fairbanks area locations, arsenic in well water has been measured to exceed the drinking water standard by a factor of 1,000.

EPA recommended arsenic levels	
Less than 10 ppb	Drinking water
Less than 100 ppb	Watering garden and livestock
Less than 500 ppb	Bathing and washing

Is there arsenic in the well water of my neighborhood?

In the Fairbanks area, several studies have looked at the distribution of arsenic in groundwater by testing water from randomly distributed, private wells. Although **there is extreme variability in the amount of arsenic** in adjacent wells, overall some areas in and around Fairbanks appear to have more or less arsenic. Because of the extremely variable concentrations of arsenic in well water, **all wells in Alaska should be tested annually for arsenic**. Arsenic concentrations in groundwater will naturally vary over time with changes in rainfall and subsequent groundwater recharge, drawdown from wells, thawing permafrost, etc. Arsenic mitigation systems, such as reverse osmosis systems, should be maintained and resultant water should also be tested.

Area of Study	Average Arsenic Concentrations (Estimated)	Range of Arsenic Concentrations
Fairbanks (including Ester Dome)	180 ppb	0 – >10,000 ppb
Ester Dome	210 ppb	<3 – 1,160 ppb
Steele Creek	70 ppb	0 – 5,100 ppb
Goldstream/ Murphy Dome	66 ppb	0 – 1,600 ppb
Chena Ridge	3 ppb	0 – 28 ppb



Tintina Gold Province. Figure from http://pubs.usgs.gov/fs/2007/3061/

Where does the arsenic come from?

The Golden Heart of the Interior is known for its history of gold exploration and production, which continue to this day. Gold prospects and mines follow an east-west, arc-shaped trend from Canada through the center of the state called the Tintina Gold Belt (or "Province"; above) by the mineral resources community. Sporadic gold mineralization in this region naturally occurs with other metals, and commonly includes arsenic. Many more unknown occurrences of arsenic, in the form of the mineral arsenopyrite and its oxidation products scorodite and iron-oxide minerals, are likely below the surface than are currently known. These underground arsenic-rich zones, usually as veins or scattered disseminations, are the source of the arsenic in the groundwater.

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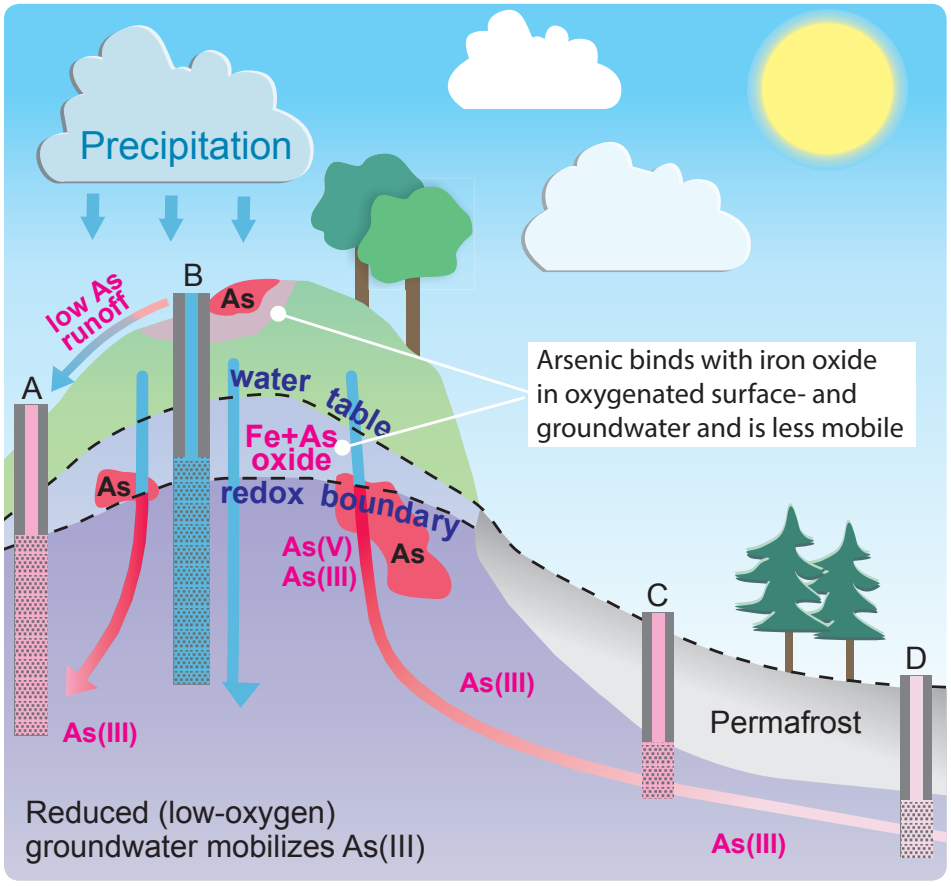
How does arsenic get into well water?

Oxygenated (oxygen-rich) and acidic groundwater in the bedrock breaks down arsenopyrite into its related iron-arsenic minerals, a portion of which may become the inorganic As species pentavalent arsenate [As(V)]. Subsequent interaction with reduced (oxygen-poor) water transforms the arsenic into trivalent arsenite [As(III)], which is highly mobile. When arsenic is free to move about in solution, it will travel in the groundwater along fractures (cracks) in bedrock or through porous aquifers. A water well may tap one or more of these arsenic-bearing water sources (well A in the figure below), while a neighboring well may miss the contaminated sources and return groundwater that is low in arsenic (well B). Note that well B may eventually draw on arsenic-bearing water if the conditions of the aquifer change. Groundwater with high arsenic is found close to areas with arsenic-bearing rocks (wells A and C), although water with arsenic may also be able to travel a fair distance before becoming dilute enough to meet drinking water standards (well D).



Model of arsenic mobility in Interior Alaska.

What are the health effects of arsenic?

Exposure to arsenic can cause a variety of health problems, including an increased risk of developing certain cancers. More information can be found here: https://www.atsdr.cdc.gov/phs/phs.asp?id=18&tid=3

More Resources

Fairbanks Area Maps & Data

Map: Arsenic, nitrate, iron, and hardness in ground water, Fairbanks area, Alaska
http://www.dggs.alaska.gov/pubs/id/12194

Map: Arsenic, nitrate, iron, and hardness, in ground water, Goldstream Road, Yankovich Road, and Murphy Dome Road areas
http://www.dggs.alaska.gov/pubs/id/12149

Map: Arsenic, nitrate, iron, and hardness in ground water, Chena Ridge vicinity
http://www.dggs.alaska.gov/pubs/id/12078

Map: Arsenic, nitrate, iron, and hardness in ground water, Chena Hot Springs Road, Steele Creek Road, and Gilmore Trail areas
http://www.dggs.alaska.gov/pubs/id/12087

Report: Arsenic in water, soil, bedrock, and plants of the Ester Dome area
https://scholarworks.alaska.edu/handle/11122/1460

Report: Chemical analyses of ground and surface waters, Ester Dome
http://pubs.usgs.gov/of/2003/ofr-03-244/

Helpful Agencies

UAF Cooperative Extension Service
https://www.uaf.edu/ces

DEC Drinking Water Program and Water Testing Information
http://dec.alaska.gov/eh/dw.aspx

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