

Arsenic in Our Environment

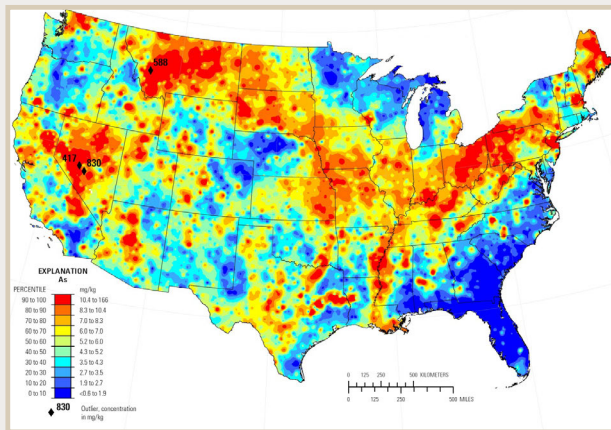
Arsenic Is Naturally Occurring

Nearly everyone is exposed to small amounts of arsenic every day without adverse health effects. Arsenic is a naturally occurring element that is widely distributed in the Earth's crust. Small amounts of arsenic are all around us, in the soils we walk on; the dusts we breathe; the groundwater we drink; and the streams and lakes we swim in, eat fish from and use for municipal water supplies.

Arsenic occurs naturally at low levels in phosphate rocks and in phosphate fertilizers we use on lawns, vegetables, flowers and orchards.



Arsenic in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,¹ shows relative amounts of naturally occurring arsenic in surface soils across the United States. The USGS data shows that national average arsenic concentration in surface soils in the U.S. is approximately 6.4 mg/kg² but can range much higher in some areas of the country.

Arsenic in Food

Arsenic in soils and water is taken up by plants, crops and livestock and gets incorporated into our diets. Seafood, rice, mushrooms and chicken are some of the foods with the highest levels of arsenic. Beer, wine and some fruit juices can contain significant amounts of arsenic as well.

According to the Centers for Disease Control (CDC), "Since arsenic is found naturally in the environment, you will be exposed to some arsenic by eating food, drinking water, or breathing air."³



1 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>.

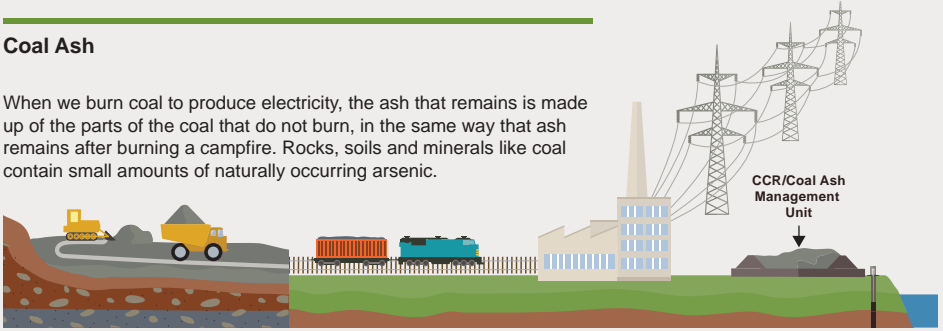
2 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>

3 www.atsdr.cdc.gov/ToxProfiles/tp2-c1-b.pdf, page 3.

Coal Ash and Arsenic

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring arsenic.

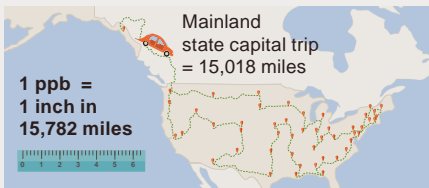


Groundwater Monitoring

The EPA requires electric utilities to measure levels of arsenic in groundwater from wells next to coal combustion residuals (CCR) management units.

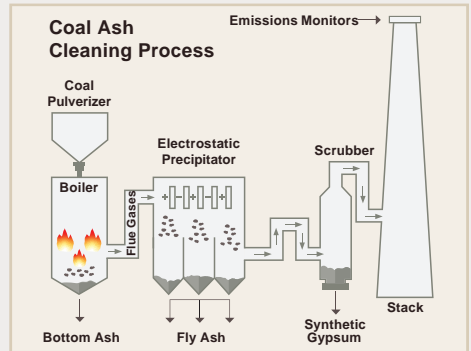
The groundwater sample results are compared to the EPA drinking water standard of 10 ug/L (parts per billion). For comparison, the CDC reports that wine can contain up to 33 ug/L arsenic, and juices and instant cocoa can contain up to 13 ug/L arsenic.⁴

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



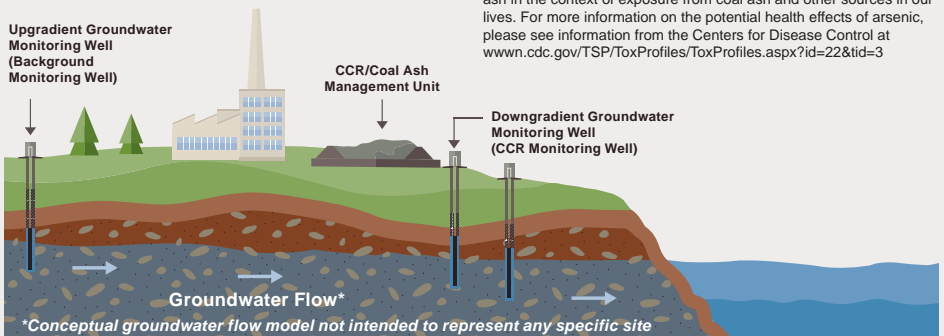
Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to arsenic from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.



⁴ www.atsdr.cdc.gov/ToxProfiles/tp2.pdf, p. 352

This publication provides information on constituents present in coal ash in the context of exposure from coal ash and other sources in our lives. For more information on the potential health effects of arsenic, please see information from the Centers for Disease Control at www.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=22&tid=3



Boron in Our Environment

Boron Is Naturally Occurring

Most of the world's boron is present in our oceans. Seawater contains about 4,600 micrograms per liter (ug/L)¹ of boron. Boron levels in freshwater streams and in groundwater are lower (35 to 100 ug/L).

Boron levels generally are higher in western U.S. surface soils, up to 300 milligrams per kilogram (mg/kg)² in desert soils, while boron levels average about 31 mg/kg in soils east of the Mississippi River.

Boron is an essential nutrient for plants and is an ingredient in plant fertilizers that you use on your lawn and farmers use for their crops. However, like other essential nutrients, having too much boron in the soil can harm plants.



Boron Abundance and Uses

Boron is present in over 200 different naturally-occurring minerals. Boron is used in soaps, cosmetics, and pharmaceuticals, including most eyewashes. Some detergents, including 20 Mule Team Borax™, are mostly sodium borate. It is also present in some dietary supplements. Boron is used in manufacturing glassware and ceramics — Pyrex™ bakeware owes its heat strength to boron.³

Boron in Food

Because boron is present in soils and water, it also is present in plants and the foods we eat. The highest boron content is in foods such as raisins, peanut butter, peanuts, dried fruits and avocados. Vegetarians tend to consume more boron than non-vegetarians because of their plant-based diet. Coffee is considered to be the largest source of boron to the adult diet, owing mostly to how much we drink!⁴



The Centers for Disease Control (CDC) does not consider boron to be an essential element for humans nor a carcinogen. EPA has not developed a drinking water standard for boron, but does have a screening level of 4,000 ug/L (parts per billion).

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1 <https://pubs.usgs.gov/wsp/wsp2254/>

2 <https://pubs.usgs.gov/pp/1270/>

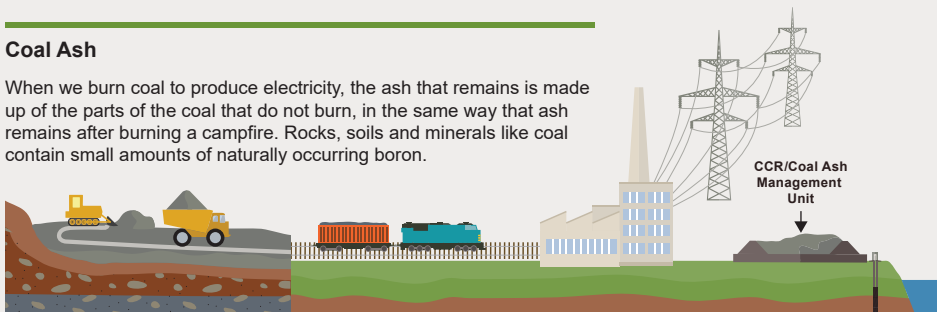
3 www.atsdr.cdc.gov/toxprofiles/tp26.pdf

4 www.atsdr.cdc.gov/toxprofiles/tp26.pdf, pages 148-150.

Coal Ash and Boron

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring boron.



Groundwater Monitoring

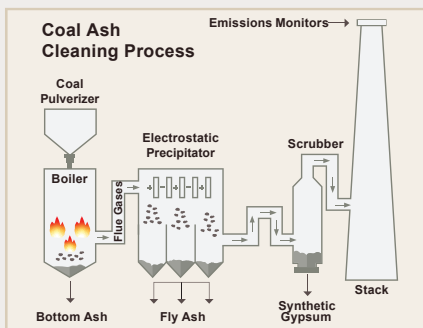
The EPA requires electric utilities to measure levels of boron in groundwater from wells next to coal combustion residuals (CCR) management units.

Coal comes from ancient plant-filled swamps, and because all plants need boron, boron is present in the coal, and in coal ash. Boron dissolves easily in water and typically moves with the flow of groundwater. Boron is generally not a constituent of concern for human health risk, however, sampling groundwater for boron can be a good indicator of whether groundwater has come into contact with CCR.

The EPA drinking water screening level for boron is 4,000 ug/L (parts per billion). For comparison, seawater contains about 4,600 ug/L boron. The CDC reports that wine can often contain up to 2,500 ug/L boron, and coffee can contain up to 290 ug/L boron.⁵

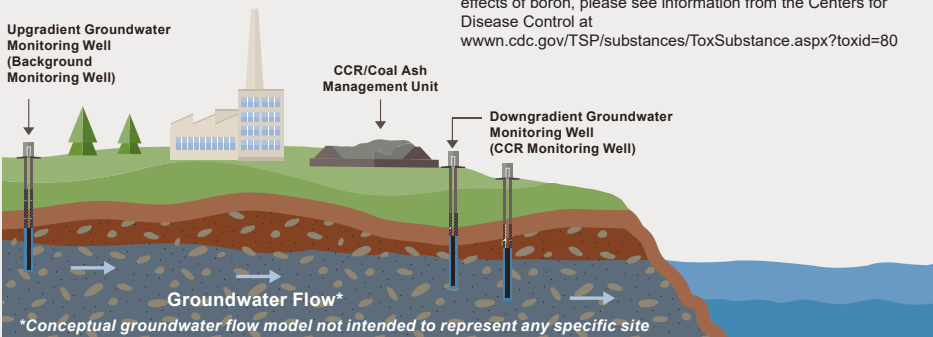
Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to boron from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.



5 www.atsdr.cdc.gov/toxprofiles/tp26.pdf, pages 148-150.

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Cadmium in Our Environment

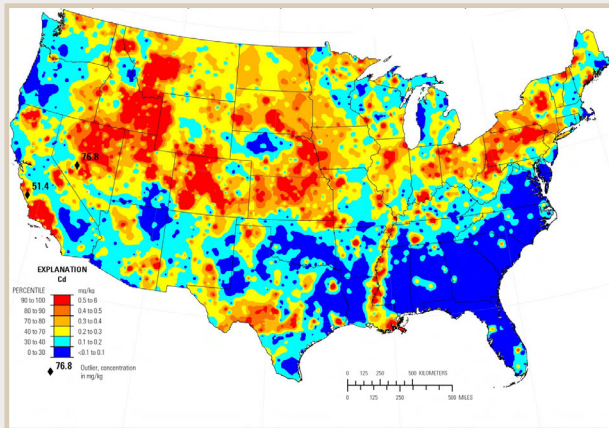
Cadmium Is Naturally Occurring

Cadmium is present in rocks, soils, and in minerals such as coal. Nearly everyone is exposed to cadmium every day through our contact with soils, the food we eat, water we drink and the air we breathe.

The dominant use of cadmium is in the manufacture of nickel-cadmium batteries. Cadmium is also used in making the popular oil painting colors, cadmium yellow and cadmium red. Cadmium chloride is used in photography, photocopying, dyeing and calico fabric printing.¹



Cadmium in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,² shows relative amounts of naturally occurring cadmium in surface soils across the United States. The USGS data shows that national average cadmium concentration in surface soils in the U.S. is approximately 0.3 mg/kg³ but can range much higher in some areas of the country.

Cadmium in Food

Cadmium is naturally present in some foods; levels in food can vary greatly. In general, leafy vegetables such as lettuce and spinach contain relatively high levels of cadmium, as do potatoes and grains. Peanuts, soybeans and sunflower seeds also may have naturally high levels of cadmium. Meat and fish tend to contain lower amounts of cadmium, except for organ meats such as kidney and liver.¹



1 www.atsdr.cdc.gov/toxprofiles/tp5.pdf

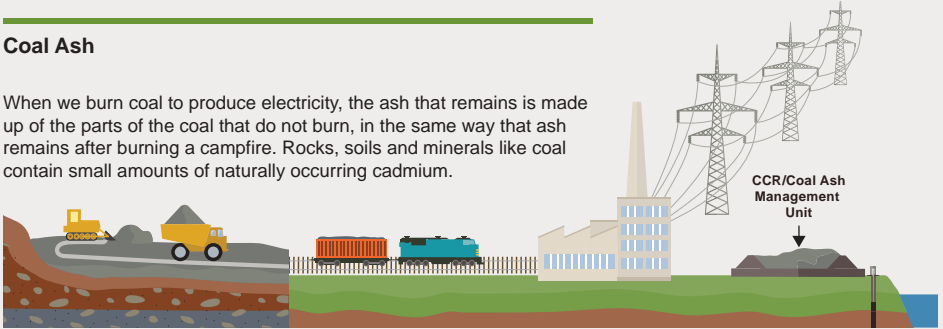
2 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>

3 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>

Coal Ash and Cadmium

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring cadmium.

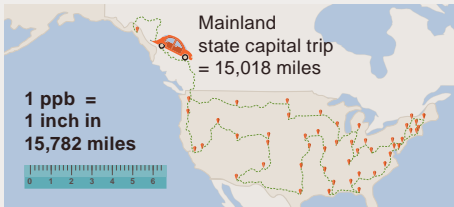


Groundwater Monitoring

The EPA requires electric utilities to measure levels of cadmium in groundwater from wells next to coal combustion residuals (CCR) management units.

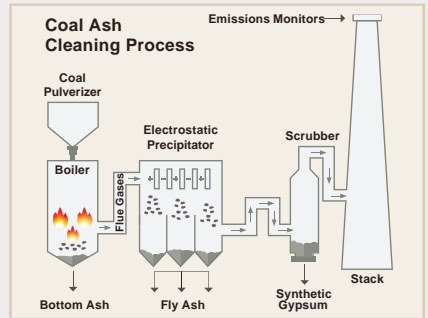
The EPA drinking water screening level for cadmium is 5 ug/L (parts per billion). For comparison, ½ cup of shelled sunflower seeds contains 21 ug cadmium⁴ – more than the amount in a whole day’s consumption of drinking water containing cadmium at EPA’s 5 ug/L drinking water standard.

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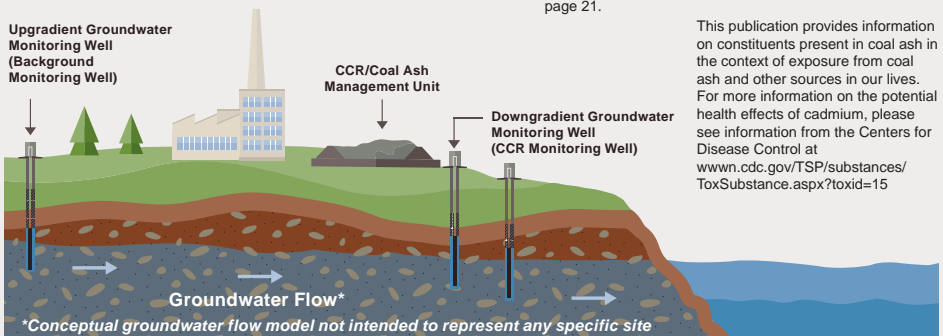


Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to cadmium from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.



4 FDA. Total Diet Study Statistics on Element Results - 2006-2011. www.fda.gov/food/science-research-food/total-diet-study. page 21.



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Cobalt in Our Environment

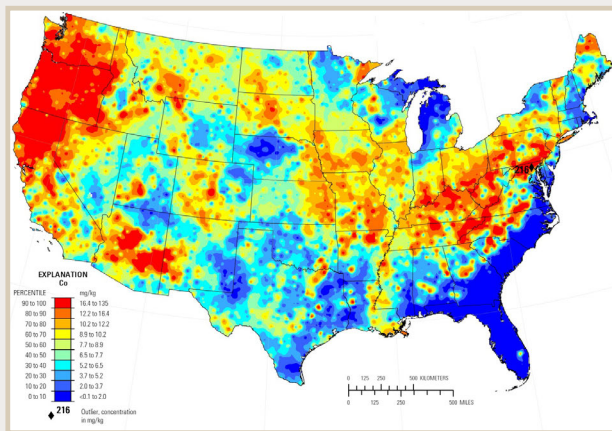
Cobalt Is Naturally Occurring

Cobalt is present in rocks, soils and minerals such as coal. Everyone is exposed to low levels of cobalt daily through the food we eat, the beverages and water we drink, and the air we breathe. Cobalt is an important part of alloys used in artificial hip and knee joints.¹ Cobalt is a critical component of lithium-ion batteries in cellphones, power tools and, more recently, electric vehicles. In fact, in the short and medium terms, cobalt is considered the highest material supply chain risk for electric vehicles.²

Cobalt blue is a well-known color in the art world. It was used in ancient Chinese blue and white porcelains. Cobalt became common in paintings in the 1800s by the impressionists, most notably Renoir, and in Van Gogh's "Starry Night", and is used still today.³



Cobalt in Soil

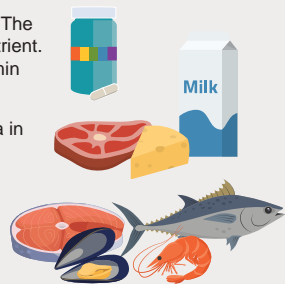


This map, adapted from a U.S. Geological Survey (USGS) report,⁴ shows relative amounts of naturally occurring cobalt in surface soils across the United States. The USGS data shows that national average cobalt concentration in surface soils in the U.S. is approximately 8.9 mg/kg⁵ but can range much higher in some areas of the country.

Cobalt and Health

Cobalt is beneficial for humans because it is an important part of vitamin B12. The human body cannot make vitamin B12; thus, it is classified as an essential nutrient. In fact, only bacteria and certain other single-celled organisms can make vitamin B12, using inorganic cobalt in the environment.¹

Beef and dairy products are good sources of vitamin B12 because the bacteria in the cow's stomach make vitamin B12 that is taken up into the cow. Fish and shellfish are also important sources of vitamin B12 because they eat plankton, which in turn have consumed bacteria that make vitamin B12.¹



1 ATSDR, www.atsdr.cdc.gov/toxfaqs/tfacts33.pdf

2 DOE, 2021, Reducing Reliance on Cobalt in Lithium-Ion Batteries, www.energy.gov/eere/vehicles/articles/reducing-reliance-cobalt-lithium-ion-batteries

3 www.invaluable.com/blog/blue-color/

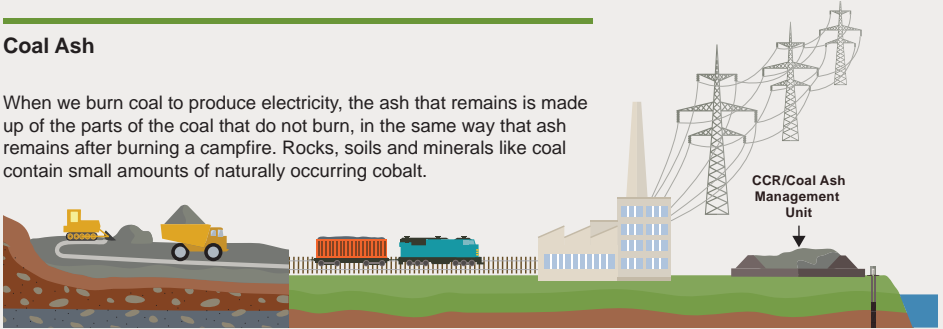
4 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>

5 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801. Table 2. <http://pubs.usgs.gov/ds/801/>

Coal Ash and Cobalt

Coal Ash

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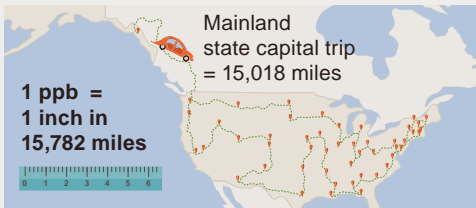


Groundwater Monitoring

The EPA requires electric utilities to measure levels of cobalt in groundwater from wells next to coal combustion residuals (CCR) management units.

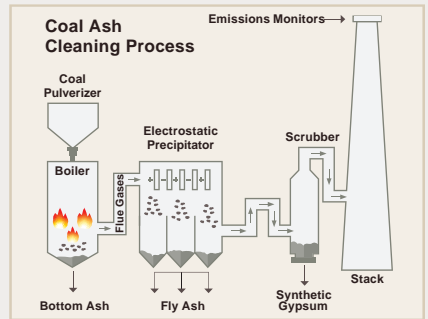
The EPA drinking water screening level for cobalt is 6 ug/L (parts per billion). For comparison, we consume an average of 11 ug of cobalt through the food we eat each day⁶ – approximately the same amount of cobalt in a whole day's consumption of drinking water with cobalt at EPA's 6 ug/L screening level.

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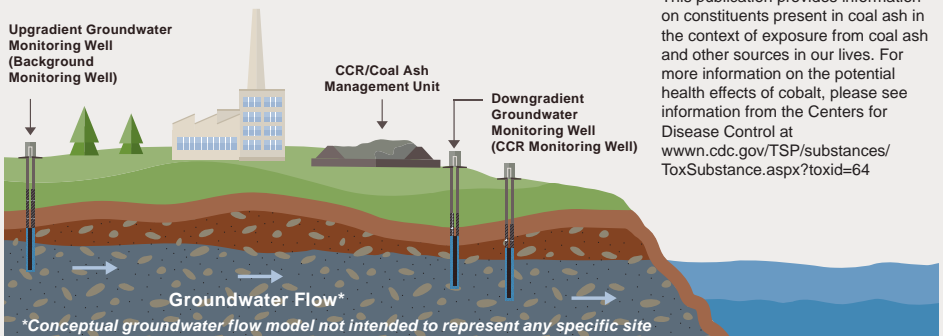
Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to cobalt from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.



6 www.mdpi.com/2304-8158/9/6/795

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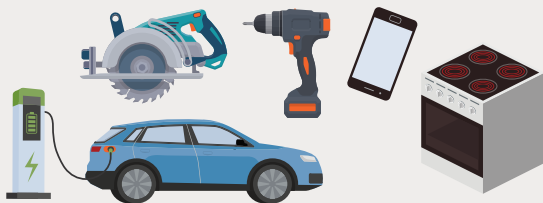


Lithium in Our Environment

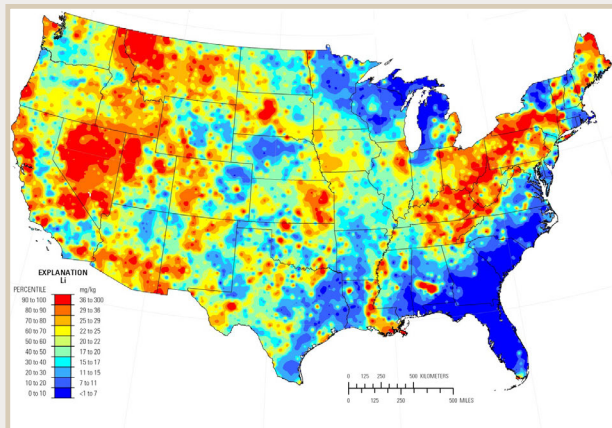
Lithium Is Naturally Occurring

Lithium is present in rocks, soils and minerals such as coal. Nearly everyone is exposed to small amounts of lithium every day through our contact with soils, the food we eat, water we drink and the air we breathe.

Lithium is the critical component of lithium-ion batteries in cellphones, power tools and, more recently, electric vehicles. It is the component in glass-topped stoves that prevents the glass from shattering when heated. It is also used as a sanitizing agent in pools, hot tubs and spas; however, with the demand for lithium in batteries, lithium products for pools are no longer available.¹



Lithium in Soil

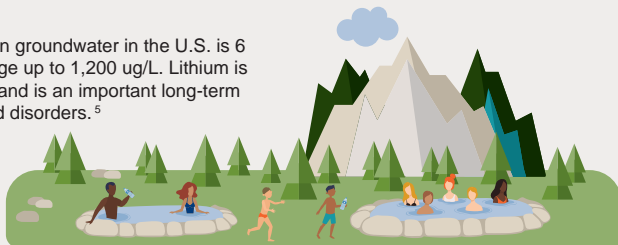


This map, adapted from a U.S. Geological Survey (USGS) report,² shows relative amounts of naturally occurring lithium in surface soils across the United States. The USGS data shows that national average lithium concentration in surface soils in the U.S. is approximately 21 mg/kg³ but can range much higher in some areas of the country.

Lithium and Health

The average concentration of lithium in groundwater in the U.S. is 6 ug/L (or parts per billion)⁴ but can range up to 1,200 ug/L. Lithium is commonly present in mineral springs and is an important long-term therapeutic treatment for bipolar mood disorders.⁵

Some studies suggest that areas where drinking water concentrations of lithium are naturally high have lower rates of violent crimes and suicide.⁶



1 <https://cfpub.epa.gov/ncea/prptv/documents/Lithium.pdf>

2 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>

3 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2. <http://pubs.usgs.gov/ds/801/>

4 <http://pubs.usgs.gov/sir/2011/5059>

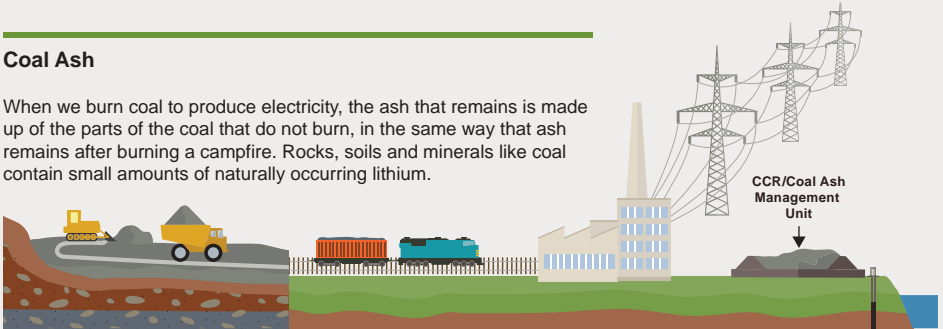
5 Therapeutic doses range from 147 to 343 mg lithium per day; <https://cfpub.epa.gov/ncea/prptv/documents/Lithium.pdf>

6 <https://link.springer.com/content/pdf/10.1007/s12011-018-1455-2.pdf>, www.cambridge.org/core/journals/the-british-journal-of-psychiatry/article/association-between-naturally-occurring-lithium-in-drinking-water-and-suicide-rates-systematic-review-and-metaanalysis-of-ecological-studies/B7DDAF6E2AB18C45EA64F3424E12D67A

Coal Ash and Lithium

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring lithium.



Groundwater Monitoring

The EPA requires electric utilities to measure levels of lithium in groundwater from wells next to coal combustion residuals (CCR) management units.

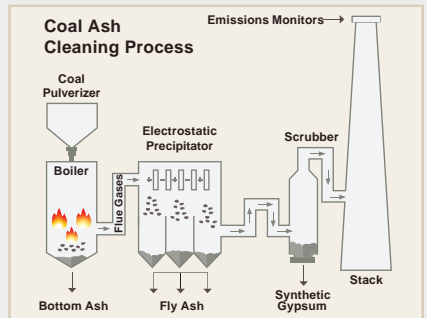
The EPA drinking water screening level for lithium is 40 ug/L (parts per billion). For comparison, concentrations of lithium in red wines, white wines and energy drinks average between 8 and 11 ug/L.⁶ Some bottled mineral waters have over 1,000 ug/L lithium.⁷ Bottled water is available from a mineral spring in the state of Georgia that contains 500 ug/L lithium.⁸

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Coal Ash and People

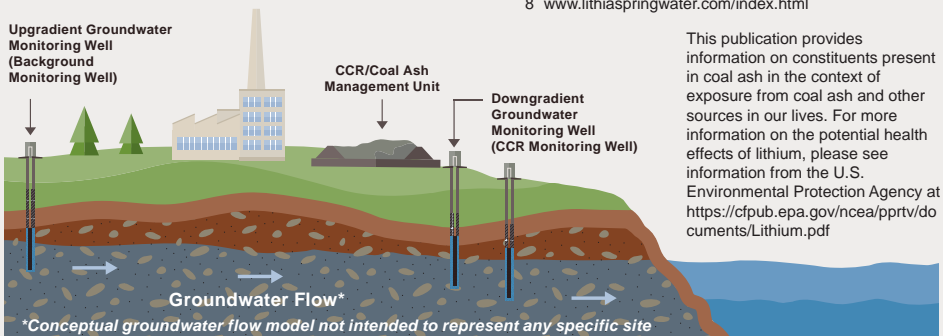
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6 www.mdpi.com/2304-8158/9/6/795

7 www.mdpi.com/1660-4601/17/22/8369

8 www.lithiaspringwater.com/index.html



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Molybdenum in Our Environment

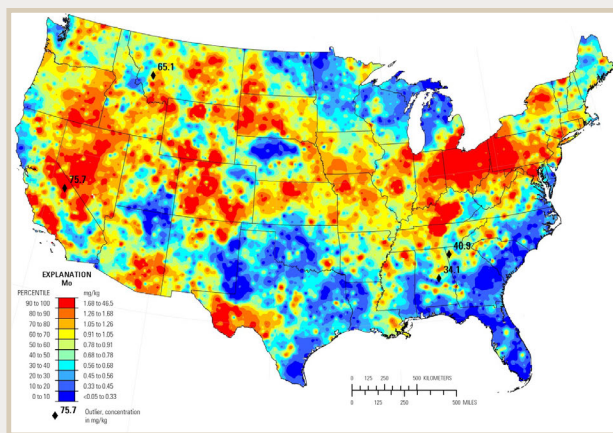
Molybdenum Is Naturally Occurring

Molybdenum is a naturally occurring element in rocks, soils and minerals such as coal. We are exposed to low levels of molybdenum every day, mostly in food. In fact, it is an essential nutrient, and a small amount of it is needed by the body to maintain proper metabolism.¹

Molybdenum is an important component of cast iron and steel and is used in lubricants and paints. It is becoming more and more important in green technologies such as manufacturing solar panels and wind turbine blades.²



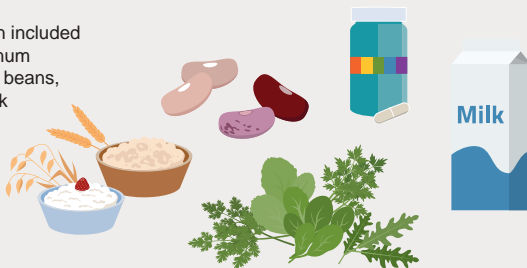
Molybdenum in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,³ shows relative amounts of naturally occurring molybdenum in surface soils across the United States. The USGS data shows that national average molybdenum concentration in surface soils in the U.S. is approximately 1 mg/kg⁴ but can range much higher in some areas of the country.

Molybdenum and Health

Molybdenum is an essential nutrient and is often included in nutritional supplements. We get the molybdenum required for human nutrition from foods such as beans, cereal grains and leafy vegetables. Milk and milk products are also an important source, with concentrations in milk around 35 ug/L (or parts per billion).⁵



1 ATSDR, www.atsdr.cdc.gov/toxfaqs/tfacts212.pdf

2 www.atsdr.cdc.gov/ToxProfiles/tp212.pdf, page 89.

3 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2. <http://pubs.usgs.gov/ds/801/>

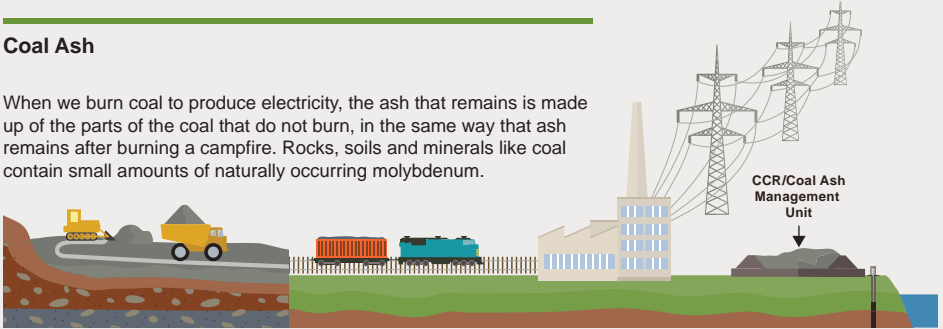
4 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>

5 www.atsdr.cdc.gov/ToxProfiles/tp212.pdf, pages 2 and 106.

Coal Ash and Molybdenum

Coal Ash

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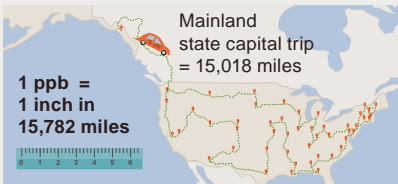


Groundwater Monitoring

The EPA requires electric utilities to measure levels of molybdenum in groundwater from wells next to coal combustion residuals (CCR) management units.

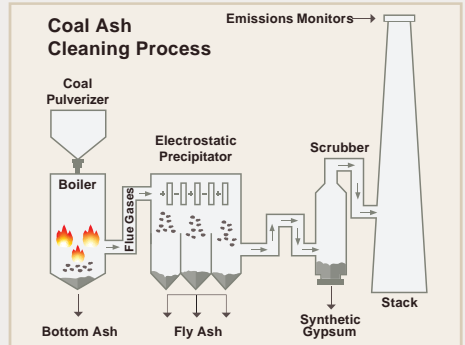
The EPA drinking water screening level for molybdenum is 100 ug/L (parts per billion). For comparison, one serving of black-eyed peas contains more molybdenum than a whole day's consumption of drinking water with molybdenum at EPA's 100 ug/L screening level.⁶

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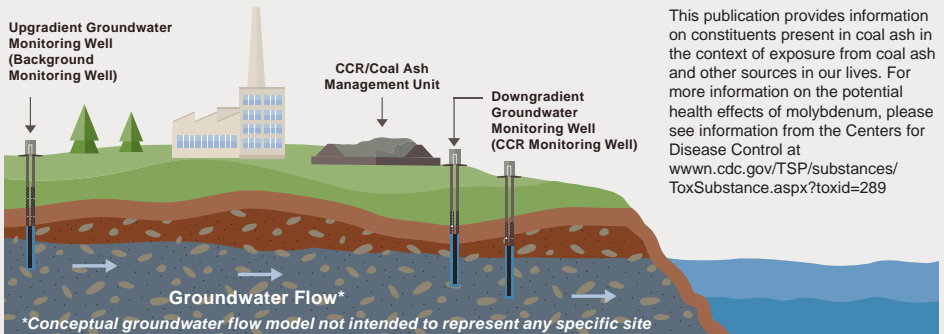


Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to molybdenum from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.



⁶ <https://ods.od.nih.gov/factsheets/Molybdenum-HealthProfessional/>



This publication provides information on constituents present in coal ash in the context of exposure from coal ash and other sources in our lives. For more information on the potential health effects of molybdenum, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=289

Selenium in Our Environment

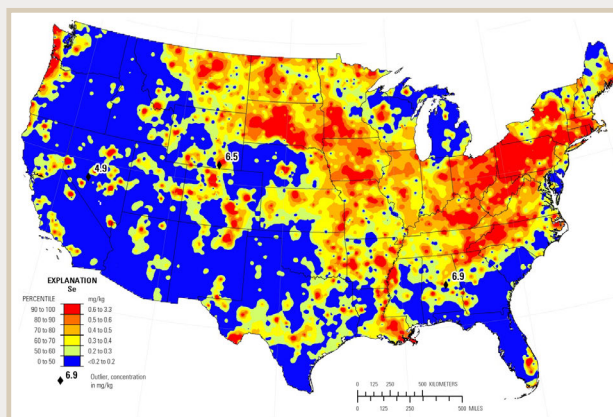
Selenium Is Naturally Occurring

Selenium is a naturally occurring element that is distributed widely in nature in rocks, soils and minerals such as coal.¹ Everyone is exposed to low levels of selenium daily through the food we eat, the beverages and water we drink, and the air we breathe.

Selenium is used in a variety of household and consumer products, such as paints, blue-tinted glass and personal care products. In fact, selenium is the active agent in several anti-dandruff shampoos, and is an antioxidant present in many dietary supplements.



Selenium in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,² shows relative amounts of naturally occurring selenium in surface soils across the United States. The USGS data shows that national average selenium concentration in surface soils in the U.S. is approximately 0.3 mg/kg³ but can range much higher in some areas of the country.

Selenium and Health

Selenium plays a critical role in healthy metabolism and thyroid function, thus is an essential nutrient for humans and other organisms. Studies show most selenium compounds are not carcinogens. In fact, studies suggest that lower-than-normal selenium levels in the diet may *increase* the risk of cancer and the presence of selenium may *prevent* some cancers.¹

As an essential nutrient, a proper daily dose of selenium is required to maintain good health. Most people get enough selenium in their normal diet, but multiple vitamins include small amounts of selenium. Selenium-rich foods include Brazil nuts, salmon, tuna, shellfish, oats, eggs, and many nuts and grains.

The Recommended Dietary Allowance of selenium is 55 micrograms per day (ug/day) for men and women, and the tolerable upper daily limit for adults (i.e., a level that is still safe) is 400 ug/day.⁴



1 www.atsdr.cdc.gov/toxfaqs/tfacts92.pdf

2 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>.

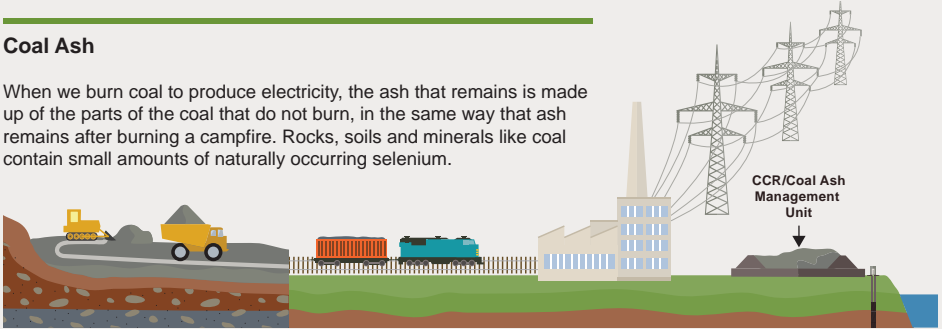
3 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>

4 NIH. 2019. Selenium Fact Sheet for Consumers. <https://ods.od.nih.gov/pdf/factsheets/Selenium-Consumer.pdf>

Coal Ash and Selenium

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring selenium.



Groundwater Monitoring

The EPA requires electric utilities to measure levels of selenium in groundwater from wells next to coal combustion residuals (CCR) management units.

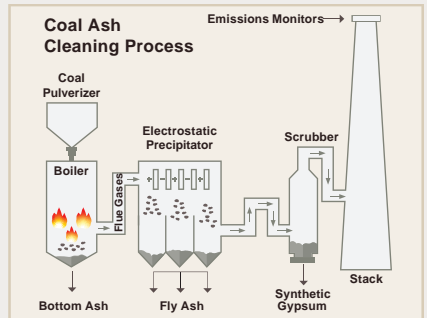
The EPA drinking water screening level for selenium is 50 ug/L (parts per billion). To put this into context, $\frac{1}{4}$ cup of Brazil nuts has 4-times as much selenium⁵ than is consumed in drinking 2 liters of drinking water that has selenium at the EPA drinking water standard.

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.

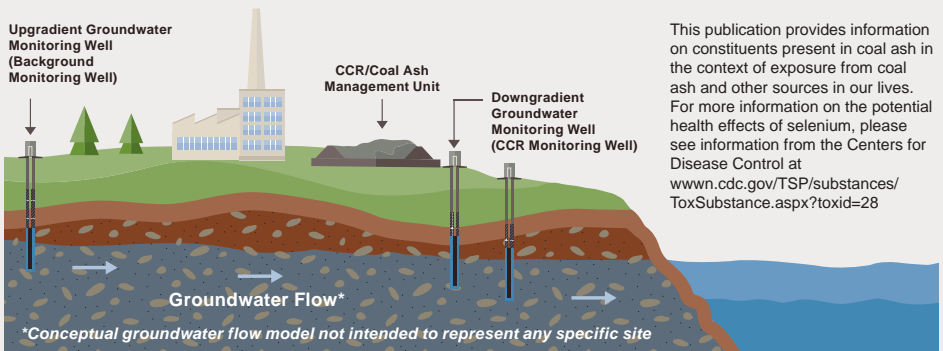


Coal Ash and People

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5 www.atsdr.cdc.gov/ToxProfiles/tp92.pdf, page 254.



This publication provides information on constituents present in coal ash in the context of exposure from coal ash and other sources in our lives. For more information on the potential health effects of selenium, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=28