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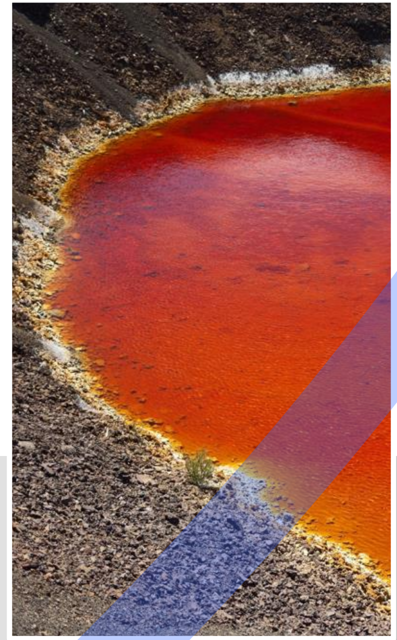
# Trace Metals



## The Trace Metals Experts

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# Trace Metals[1,2]

Trace metals in groundwater used for drinking have long been a concern because of potential adverse effects on human health and aesthetic or nuisance problems .

"Trace metals" refers to metals and semi-metallic elements that typically are found in concentrations less than one milligram per liter (mg/L) in natural waters. These metals are mobilized primarily from the weathering of rocks. Their concentrations in groundwater reflect their presence and abundance in aquifer materials, geochemical conditions (such as pH and oxidation-reduction potential), the presence and abundance of complexing ions and organic matter, and attenuation processes such as adsorption. Trace metal concentrations can also be increased due to anthropogenic activities, with some potential sources[3] listed below.

**Agriculture**
- Fertilizers
- Animal Manures
- Pesticides
- Irrigation Practices

**Electronics/E-waste**
- Circuit Boards
- Appliances
- Wiring

**Waste Disposal**
- Sewage Sludge
- Municipal Refuse
- Waste Incinerators

**Energy Production**
- Leaded Gasoline
- Battery Manufacturing
- Power Plants
- Coal Combustion Products (CCPs)
- Oil Fields

**Metallurgy**
- Mining
- Smelting
- Metal Finishing
- Electrolysis

About 20% of untreated water samples from public, private, and monitoring wells across the nation contain concentrations of at least one trace element at levels of potential health concern. Trace metals in groundwater exceed human health benchmarks more frequently than most other groundwater contaminants, such as nitrate, pesticides, and volatile organic compounds (VOCs).

Differences in the concentration of trace metals are related to the climatic conditions and land use of the area. Typically, higher concentrations of trace metals in groundwater are observed in drier areas of the United States than humid regions. Wells in agricultural areas more often contain trace metals than those in urban areas. However, wells in urban areas contain concentrations of trace metals that more often exceeded human health benchmarks.

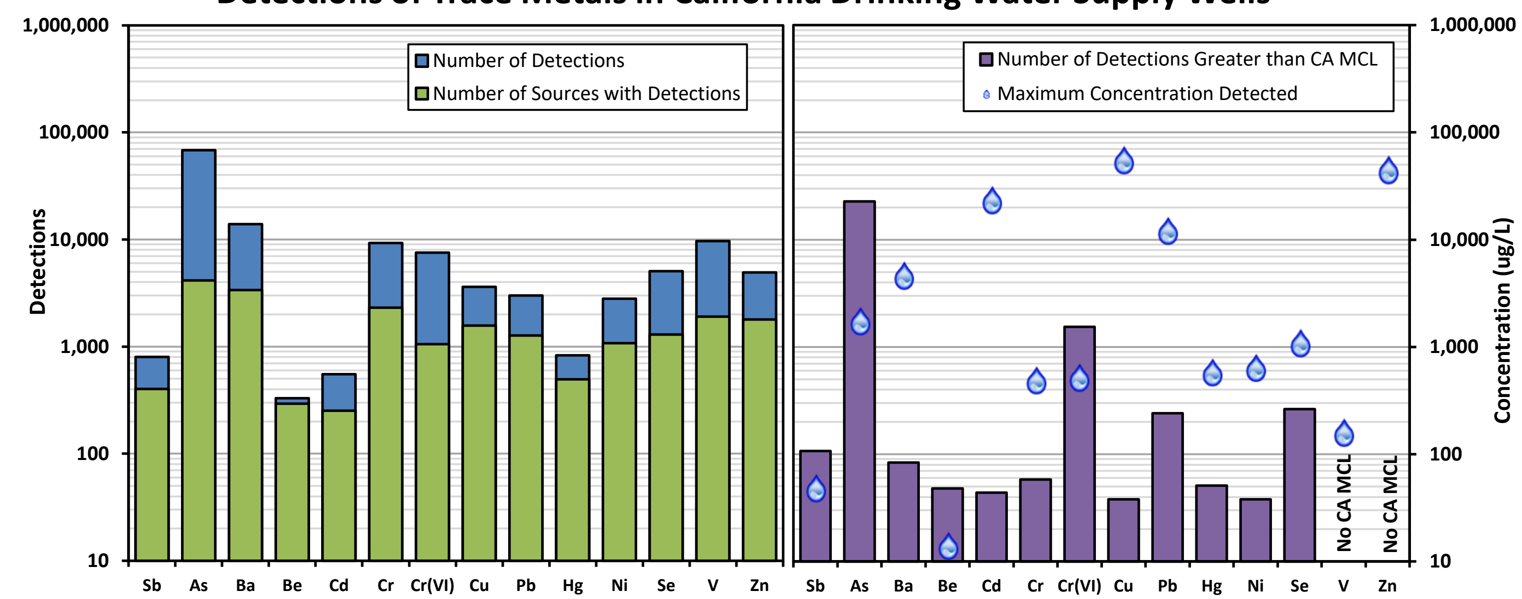
Sources:
1. Ayotte, J.D., *et al.* (2011). Trace elements and radon in groundwater across the United States, 1992–2003: U.S. Geological Survey Scientific Investigations Report 2011–5059, 115 p. (http://pubs.usgs.gov/sir/2011/5059.) http://pubs.usgs.gov/sir/2011/5059/pdf/sir2011-5059_report-covers_508.pdf)
2. http://www.usgs.gov/newsroom/article.asp?ID=2914#.Uh5ZPxttqSo
3. Adriano, D. C. (2001). Trace elements in terrestrial environments: biogeochemistry, bioavailability, and risks of metals. Springer
4. USGS (1984). Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. (http://pubs.usgs.gov/pp/1270/pdf/PP1270_508.pdf)

## Properties of Selected Trace Metals

| Trace Metal | | Molecular Weight (g/mol) | Sorption[9] (Log $K_{oc}$) (unitless) | Log $K_{ow}$[9] (unitless) | Background Soil Concentrations[4] | | Background Groundwater Concentrations[1] | | Regulatory Levels | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Mean (mg/kg) | Range (mg/kg) | Median (µg/L) | Range (µg/L) | CA PHG (µg/L) | CA MCL (µg/L) | US MCL (µg/L) |
| **Antimony** | Sb | 121.7 | 1.65 | - | 0.66 | <1 - 8.8 | <1 | <1 - <1 | 20 | 6 | 6 |
| **Arsenic** | As | 74.9 | 1.4 | 0.68 | 7.20 | <0.1 - 97 | 0.79 | 0.079 - 7.4 | 0.004 | 10 | 10 |
| **Barium** | Ba | 137.3 | 1.04 | - | 580 | 10 - 5,000 | 54 | 9 - 220 | 2,000 | 1,000 | 2,000 |
| **Berylium** | Be | 9 | 1.36 | 0.57 | 0.92 | <1 - 15 | <1 | <1 - <1 | 1 | 1 | 4 |
| **Cadmium** | Cd | 112.4 | 1.18 | -0.07 | - | 0.1 - 1[5] | <1 | <1 - <1 | 0.04 | 5 | 5 |
| **Chromium** | Cr | 52 | 3.08 | - | 54 | 1 - 2,000 | 1.2 | 0.41 - 5.2 | - | 50 | 100 |
| **Hexavalent Chromium** | Cr(VI) | 52 | 1.15 | - | - | 0.06 - 0.46[6] | - | <1 - 180[6] | 0.02 | 10 | - |
| **Copper** | Cu | 63.5 | 1.6 | -0.57 | 25 | <1 - 700 | 1 | 0.2 - 8.5 | 30 | 1,300 | 1,300 |
| **Lead** | Pb | 207.2 | 1 | 0.73 | 19 | <10 - 700 | 0.07 | 0.005 - 1 | 0.2 | 15 | 15 |
| **Mercury** | Hg | 200.6 | 1.72 | -0.47 | 0.09 | <0.01 - 4.6 | - | 0.03 - 0.56[7] | 1.2 | 2 | 2 |
| **Nickel** | Ni | 58.7 | 1.2 | -0.57 | 19 | <5 - 700 | 1.1 | 0.15 - 4.9 | 12 | 100 | - |
| **Selenium** | Se | 79 | 0.34 | 0.24 | 0.39 | <0.1 - 4.3 | 0.34 | 0.041 - 3 | 30 | 50 | 50 |
| **Vanadium** | V | 50.9 | 3 | - | 80 | <7 - 500 | 1.4 | 0.11 - 27 | - | - | - |
| **Zinc** | Zn | 65.4 | 1.2 | -0.47 | 60 | <5 - 2,900 | 4.8 | 0.43 - 69 | - | - | - |

Notes: $K_{ow}$ = octanol-water partition coefficient; $K_{oc}$ = organic carbon partition coefficient; MCL = maximum contaminant level; PHG = preliminary health goal; Range: 10th to 90th percentile

## Detections of Trace Metals in California Drinking Water Supply Wells[8]




Sources:
5. Page, A.L., *et al*. (1987). Cadmium Levels in Soils and Crops in the United States. Ch. 10. (http://dge.stanford.edu/SCOPE/SCOPE_31/SCOPE_31_2.05_Chapter10_119-146.pdf)
6. Guertin, J, J.A. Jacobs and C.P. Avakien (2005). Chromium (VI) Handbook
7. http://nfp-at.eionet.eu.int/Public/irc/eionet-circle/bridge/library?l=/deliverables/bridge_deliverable/ch5inorganicspdf/_EN_1.0_&a=d
8. California Department of Public Health (DPH) Water Quality Analyses Data from 2006 to 2013 (http://www.cdph.ca.gov/certlic/drinkingwater/Pages/EDTlibrary.aspx)
9. http://www.gsi-net.com/en/publications/gsi-chemical-database/list.html