BROOKS APPLIED LABS

Advanced Analytical Services for the Determination of
Mercury & Methylmercury

Despite being one of the rarest elements in the planet's crust, even modest increases in the quantity of mercury being introduced into the global environment is a matter of considerable and growing concern. Mercury contamination can threaten the health of humans and wildlife, from industrial sites to the most remote wilderness areas.

Significant natural sources of mercury include orogenic belts containing highly concentrated forms of mercury that are continuously released through weathering, geothermal activity that volatilizes and transports mercury from deep deposits to the surface, and episodic volcanic eruptions that send gaseous elemental mercury high into the atmosphere.

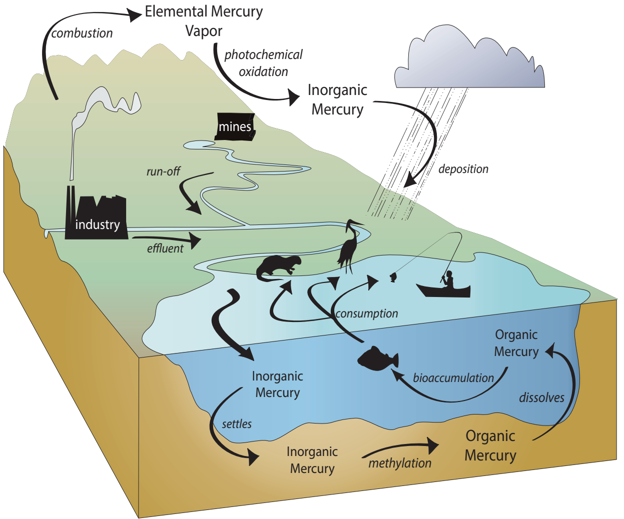
These natural sources have been found to be relatively consistent in the amount of mercury that they introduce into the global environment over extended periods of time. In contrast, anthropogenic activity has substantially increased the mobilization of mercury into the environment and is by most estimates responsible for considerably more than half of all contamination.

For centuries mercury has been used extensively to extract precious metals from ore and was heavily mined directly from cinnabar deposits specifically for this purpose. Mercury has also been utilized in items ranging from household products to military munitions that have subsequently been buried in landfills or incinerated. Cement and chlor-alkali plants also contribute significant amounts of mercury to the environment.

However, as much as eighty percent of all anthropogenic mercury is attributable to energy production, especially coal combustion. Bituminous coal can contain relatively high levels of mercury and during combustion it is volatilized into gaseous elemental mercury vapor. Without implementation of the most sophisticated pollution controls available, this vapor is emitted into the atmosphere.

Areas in close proximity to coal-fired power plants can have measured deposition concentrations more than five times greater (shown in dark red) than the equivalent pre-industrial levels (shown in dark green). Few areas in the contiguous United States receive deposition amounts consistent with what would historically occur as a result of natural processes.

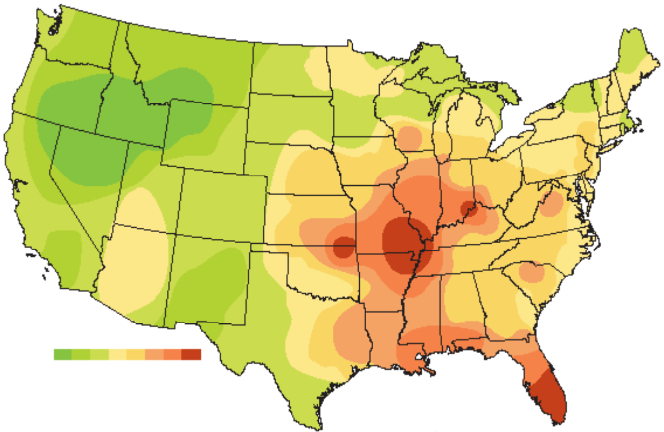
Elemental mercury vapor emitted into the atmosphere will eventually be converted by photochemical oxidation into inorganic mercury and deposit, mostly through precipitation, onto land or into water bodies. Easily mobilized in water, inorganic mercury from deposition, mine tailings, or industrial effluents can reach larger aquatic systems.



Fate & Transport of Anthropogenic Mercury

The potential for mercury contamination to become an even more serious human and environmental health issue largely depends on whether the location in which it arrives is favorable to the conversion of inorganic mercury to the significantly more toxic organic form of methylmercury.

Research suggests that as inorganic mercury settles into the sediment of aquatic systems, prevailing anaerobic microorganisms are largely responsible for this methylation process. Particularly common locations for the methylation of mercury are wetlands, low-alkalinity lakes, organic-acid rich systems, recently flooded areas, and streams where severe level fluctuations occur.



Estimated Relative Mercury Deposition Concentrations

With a half-life of about seventy days in aquatic organisms, methylmercury will bioaccumulate within individual organisms and then biomagnify up trophic levels. Large piscivorous fish can have concentrations of methylmercury more than a million times greater than the surrounding water. The most prevalent means of human exposure to mercury pollution is through the consumption of fish containing elevated concentrations of methylmercury.

Responsible for more than three-quarters of all fish consumption advisories in the United States, methylmercury is a pollutant of the highest concern and it is likely that it will become a requirement that it be widely monitored.

Since 1982, Brooks Applied Labs has devoted significant resources to the research and development of the analytical methods and instrumentation necessary to quantify mercury and methylmercury concentrations at ultra-low levels in even the most complex matrices. Our early research contributed substantially to the development and validation of EPA Method 1631 and EPA Method 1630 for the determination of mercury and methylmercury in water at sub-parts-per-trillion levels.

Over the decades we have developed and perfected our analytical methods and instrumentation to determine mercury and methylmercury concentrations in even the most complex matrices. We routinely analyze surface water, ground water, coal, soil, wastewater, seawater, sediment, fish tissue, macroinvertebrates, plankton, food, and human blood with some of the lowest detection limits available.

METHOD DETECTION LIMITS

Matrix	Hg	MeHg
water	**0.15 ng/L**	**0.010 ng/L**
sediment	**0.05 ng/g**	**0.008 ng/g**
biota	**0.04 ng/g**	**0.07 ng/g**

Our NELAC and DoD ELAP certified methods have contributed to thousands of projects including research programs, remediation projects, TMDL studies, RI/FS, and NDPES permitting. We provide analytical services to a wide range of clients including the US EPA, USGS, USACE, environmental and engineering consulting firms, universities, industrial research groups, and municipalities around the world.

Bioavailability & Mobility

When investigating mercury contaminated soils at legacy mining and industrial sites, measurements of the concentrations of total mercury in the soil are clearly necessary. However, the best approach to site remediation sometimes requires a fuller understanding of the environmental bioavailability and mobility of the particular mercury compounds found at the site.

For example, specific classes of mercury compounds are more susceptible to methylation or leaching from soils when exposed to aqueous solutions. The proximity of recreational fishing areas may be more of a concern if the mercury compounds that are present more readily undergo methylation. Significant quantities of water soluble mercury compounds may require a more thorough containment plan than required for mineral bound mercury compounds that are relatively immobile.

In order to assess the concentrations of mercury compounds in soils that belong to these specific classes, Brooks Applied Labs performs a selective sequential extraction procedure to differentiate several individual fractions according to their behavior. By sequentially utilizing increasingly strong solvents on a single sample aliquot, a supernatant liquid can be drawn off subsequent to each extraction and analyzed for total mercury concentrations while maintaining sufficiently low method detection limits.

These selective sequential extractions represent the mobility of specific classes of mercury compounds and can be classified as fractions that are water soluble, weak acid soluble, organo complexed, strongly complexed, or mineral bound. Moreover, the first three of these fractions have been shown to be significantly more susceptible to methylation and thus are more bioavailable.

Fraction	Description	Typical Compounds	Extractant
F1	water soluble	$HgCl_2$	deionized water
F2	weak acid soluble	HgO $HgSO_4$	pH 2 HCl/HOAc
F3	organo complexed	Hg-humics Hg_2Cl_2 CH_3Hg	1 M KOH
F4	strongly complexed	mineral lattice Hg_2Cl_2 Hg^0	12 M HNO_3
F5	mineral bound	HgS m-HgS HgSe HgAu	aqua regia

To learn more about our innovative and customized analytical methods and/or our highly specialized mercury speciation capabilities and how they can benefit your projects, contact us today. Please visit our website at **www.brooksapplied.com**, email us at **info@brooksapplied.com** or call **206-632-6206**.