



## Natural Resources Air Quality

### AN INTRODUCTION TO MERCURY

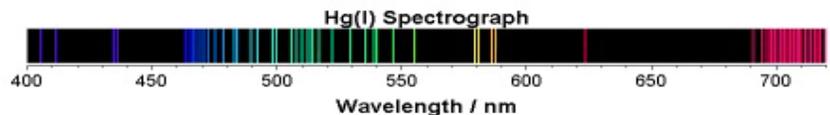
The following handout presents an eclectic selection of facts as a comprehensive introduction to mercury pollution and also asks several important questions regarding current emissions and plans for the future.



### MERCURY

From Hydrargyrum (Greek for liquid silver)

Symbol	Hg
Atomic Number	80
Atomic Weight	200.59



### PROPERTIES

- 13.5 times heavier than water - sinks readily to lake and river bottoms
- Will split into thousands of droplets very easily - this makes clean up of spills quite difficult
- Only metal to hold liquid form at ambient temperatures - vaporizes easily
- 73% reflectivity - anciently used for reflecting pools
- Electrically conductive
- Easily containable in glass - makes convenient fluorescent lights
- Alloys with most other metals (called amalgams)
- Often used in electrical switches and lighting because of its versatile properties
- Expands and contracts very little - very useful in scientific instruments
- Most common form of naturally occurring mercury is as mercuric sulfide (cinnabar)



# HISTORICAL, CULTURAL AND COMMERCIAL USES

## ANCIENT EGYPT

- Mercury has been found in Egyptian tombs of from 1500-1600 B.C.
- Systematic exploitation of mines was an important industry employing many thousands of workers and using elaborate techniques
- The management of the mines was a business venture worthy of the modern world
- From about 2900 B.C. onwards, metals seem to have been entirely monopolies of the Court, the management of the mines and quarries being entrusted to the highest officials and sometimes even to the sons of the Pharaoh
- Source: [www.touregypt.net/science.htm](http://www.touregypt.net/science.htm)



## NORTHERN CALIFORNIA

- Between 1850-1981, 114,000 tons of mercury were mined from 239 known mines
- In the Sierra Nevada, 4,000 tons of mercury have been lost to the environment due to gold mining.
- Source: [www.bemercuryfree.net/offsets.html](http://www.bemercuryfree.net/offsets.html)

## CULTURAL USE

Elemental mercury (Azogue) and mercuric oxide (precipitado rojo) are sold in botonicas throughout Latino and Caribbean communities.

From Donna Riley,  
*Mercury Use in Spiritual and Folk Traditions*  
Picker Engineering Program, Smith College  
NESCAUM Mercury Conference, June 12, 2002



## COMMERCIAL USE

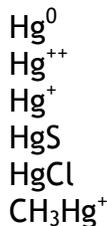
- Small-scale gold mining
- Chlor-alkaloi production
- Manometers
- Switches, lamps, florescent lights
- Dental amalgams (fillings)
- Batteries
- Vaccines (biocides catalysts)
- *Unabated demand is increasing in developing nations - much of it is illegal, uncontrolled and unregulated (UNEP Chemical)*



## PRESENCE, BEHAVIOR & EMISSIONS

### MERCURIC COMPOUNDS

- Elemental mercury
- Ionic mercuric
- Ionic mecurous
- Mercuric sulfide ores (cinnabar)
- Surface waters
- Methyl mercury



### MERCURY RELEASES

#### NATURAL

- Volcanic activity
- Forest fires
- Geothermal activity
- Ore (mostly as cinnabar)
- Natural erosion
- Small content naturally occurs in soils

#### ANTHROPOGENIC (MAN-CAUSED)

- Combustion (such as coal-fired emissions)
- Industrial processes (such as chlor-alkalai manufacture)
- Used intentionally in products (such as florescent lighting)
- Mining (gold and mercury)

#### PLEASE NOTE!

- 2/3 of the mercury load in our environment comes from anthropogenic releases
- Anthropogenic activities increase atmospheric levels up to 3 times on average globally - up to 10 times higher near industrial areas.

## HOT SPOTS EXPLAINED

A hotspot is “a region of several square kilometers in which mercury concentrations are 2 to 3 times the *expected* value for the area.”

- [www.holstoncrisci.com/Newsletter/docs/3/Sullivan.pdf](http://www.holstoncrisci.com/Newsletter/docs/3/Sullivan.pdf)

“. . . Unlike other air contaminants that disperse broadly, mercury in large measure deposits locally and tends to concentrate, creating toxic “hot spots” of contamination.

- [www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=505515](http://www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=505515)

A body of water that exceeds methyl mercury quality criterion in fish tissue that is attributable *solely* to coal-fired emissions.

- EPA

## MERCURY FALLOUT

### MERCURY GASES

- Gaseous Elemental Mercury ( $\text{Hg}^0$ ) - mostly transported globally
- Gaseous Reactive Mercury ( $\text{Hg}^{++}$ ) - mostly transported regionally (up to 650 miles)
- 97% of mercury in the global pool is elemental ( $\text{Hg}^0$ )

### THE BIG UNKNOWN

Scientists do *not* know the answer to the following question:

How much power plant  $\text{Hg}^0$  is transported globally compared to that which transforms to  $\text{Hg}^{++}$  and is subsequently deposited locally thereby causing hotspots?

### METHYL MERCURY ( $\text{CH}_3\text{Hg}^+$ )

- 95-99% of mercury found in lakes and rivers is methyl mercury
- Created when free mercury settles to the bottom of lakes and rivers and is converted by bio-organisms
- Fish become insensitive to ingesting these deposits and are able to build up a level of mercury tolerance in their tissues
- Methyl mercury is *very* toxic to humans



## GLOBAL VS. LOCAL

### OHIO RIVER VALLEY

70% of mercury wet deposition in 2003-2004 was directly attributable to local and regional coal combustion.

- [www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=505662](http://www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=505662)

### INDUSTRIAL NORTHEAST

Scientists Lee and Sigler of Yale University found that “the amount of mercury emitted to the atmosphere in the northeastern United States fluctuates annually depending on activity in the electric power industry”, 2000-2004. The scientists used tracer analysis to back track emitted mercury to combustion sources.

- [http://environment.yale.edu/doc/2303/power\\_plants\\_big\\_influence\\_in\\_regional/](http://environment.yale.edu/doc/2303/power_plants_big_influence_in_regional/)

### GREENLAND

- Inuit infants are being harmed both through the womb and through breast milk, which could be classified as hazardous waste
- 17% of village adults in the far north have blood levels of mercury high enough to cause acute mercury poisoning, 200 ppb
- Greenland has almost no industrial emissions - toxic levels of mercury are caused by anthropogenic re-mobilization called the Grasshopper Effect

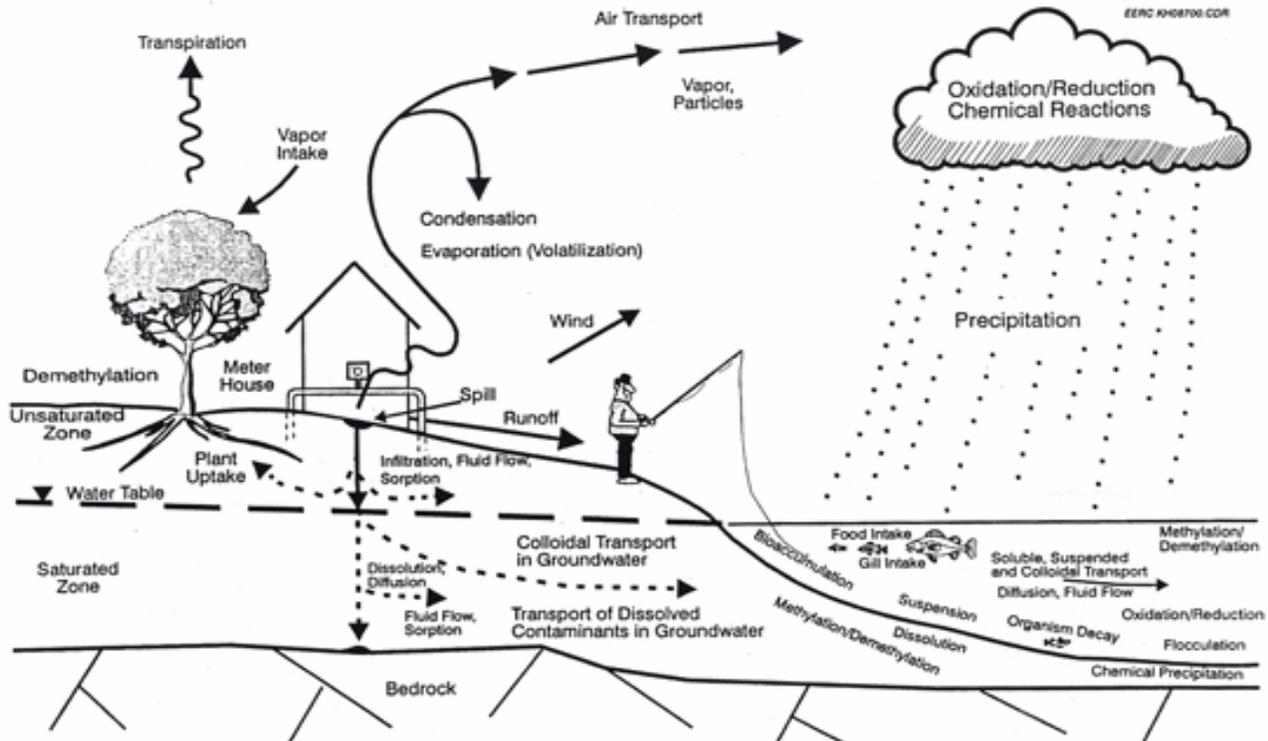
- <http://www.start.or.th/got/gotwww/mercury.html>

### THE GRASSHOPPER EFFECT



## RE-MOBILIZATION DIAGRAM

- Since mercury is an element, it *cannot degrade into non-toxic form* by ordinary chemical processes
- It vaporizes and re-emits with heating and cooling in the troposphere



## MORE INFORMATION ON MERCURY

EPA's "Roadmap for Mercury" released in July of this year, is a good general introduction on mercury with information dating through 2000. <http://www.epa.gov/mercury/roadmap.htm>

# TOXICITY



“Once released, mercury persists in the environment circulating and re-circulating in various forms. Mercury readily passes through the placental and blood-brain barriers.”

- UNEP Chemical

## BLOOD-BRAIN BARRIER

A study of 151 placentas and infants born with nerve or brain damage indicates that mercury absorbs directly through the blood-brain barrier.

BLOOD-BRAIN BARRIER - Tight junctions of endothelial cells that prevent passage of toxins between the brain and central nervous system (CNS) and the circulatory system. This barrier is disrupted by mercury and other heavy metals

- [www.sciencedaily.com/releases/999](http://www.sciencedaily.com/releases/999)

## INTELLIGENCE

Low scores on IQ, visual and motor skills testing correlates to high mercury content found in mothers.

- <http://ehp.niehs.nih.gov/docs/2005/7743/abstract.html>

## CHRONIC EXPOSURE

Chronic low-level exposure over time causes numerous problems in the central nervous system including tremors, spasms and also causes gingivitis and enlarged thyroid.

## HEART

- Finnish study shows that Finns, whose mercury intake is twice as high as Americans are also twice as likely to suffer an acute myocardial infarction.
- Both organic and ionic forms of mercury will accumulate in the heart

*European Commission proposes export ban on toxin by 2011*  
Andrew Freedman, Greenwire reporter

## MITIGATION

Environmental levels of mercury can be *greatly reduced* with tighter emission controls.

“. . . Massachusetts reports a 32%-average decrease in the level of mercury found in a signature freshwater fish caught in nine lakes in the northeastern corner of the state. The reductions come seven years after the state enacted the nation’s toughest mercury emission laws for incinerators. A Florida Everglades study showed that mercury concentrations found in fish and wading birds there dropped by 60% to 70% due to local mercury emission reduction efforts. These studies illustrate the point that local emission reduction efforts play a substantial role in improving air quality and the environment.”

- [www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=505515](http://www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=505515)

Numerous actions implemented globally have successfully reduced mercury releases.

“Nearly half of the nation has voted, or is about to act, on state-specific plans...to control [mercury] emissions from coal-fired power plants.” These include: Delaware, Florida, Illinois, Indiana, Montana, New Hampshire, New York, North Carolina, Ohio, Virginia, Washington Connecticut, Massachusetts, Maryland, New Jersey and Wisconsin.

- [www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=505515](http://www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=505515)

The extent of decreases in the environment varies greatly depending on local levels and ecosystems.

### WE MUST IMPROVE OUR UNDERSTANDING AND CONTROL ACTIONS

- Inventories - many global inventories are incomplete
- Continuing assessment of effects on humans and wildlife - how much time must pass in order to ensure safe consumption of fish?
- Collaboration - between industry, scientific community and government
- Address uncertainties in global balance of mercury
- Address uncertainties of how local emissions effect local areas
- Improve monitoring and assessment