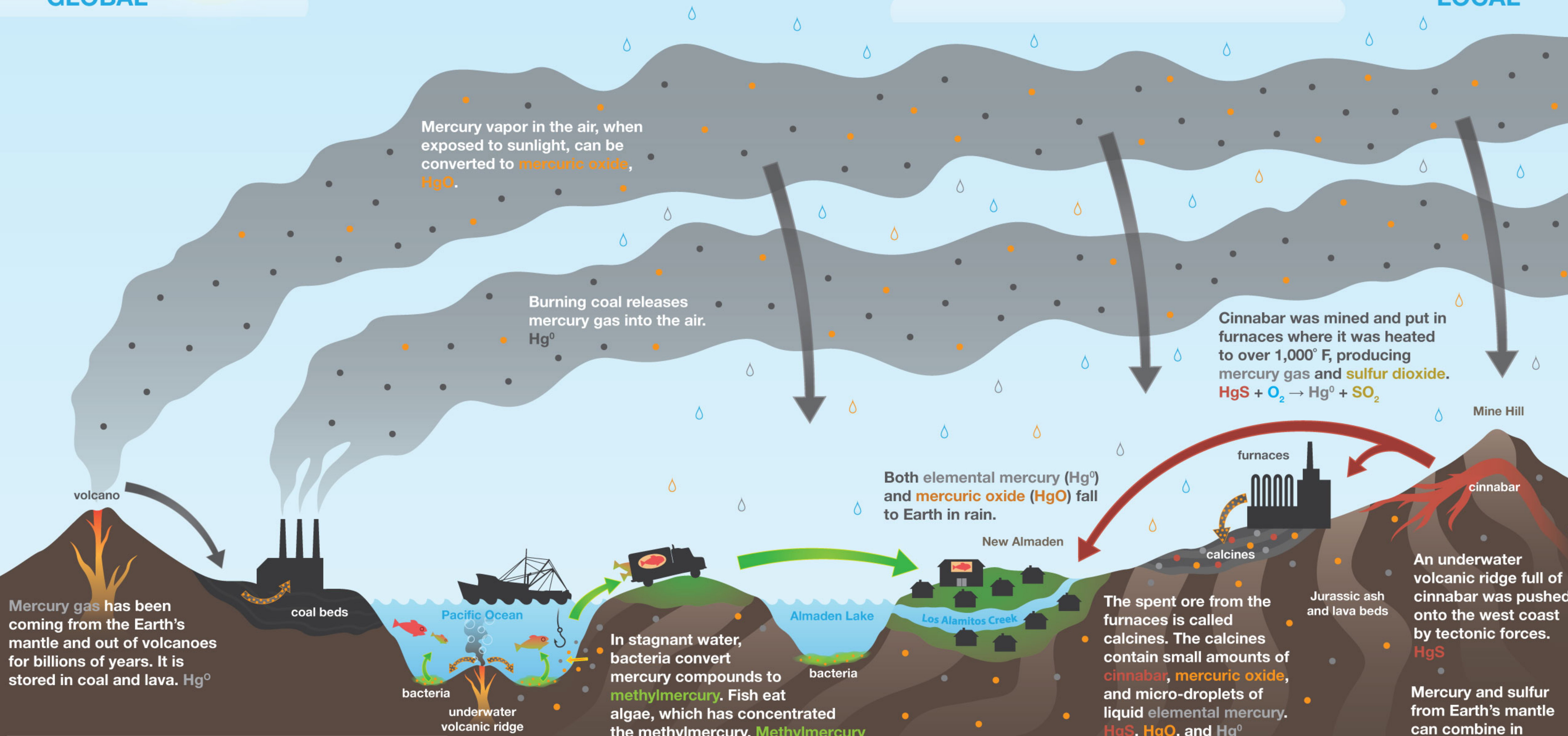


HOW DOES MERCURY GET HERE?

GLOBAL

LOCAL



Mercury vapor in the air, when exposed to sunlight, can be converted to **mercuric oxide, HgO**.

Burning coal releases mercury gas into the air. **Hg⁰**

Cinnabar was mined and put in furnaces where it was heated to over 1,000° F, producing mercury gas and **sulfur dioxide**.
 $HgS + O_2 \rightarrow Hg^0 + SO_2$

Both elemental mercury (**Hg⁰**) and **mercuric oxide (HgO)** fall to Earth in rain.

In stagnant water, bacteria convert mercury compounds to **methylmercury**. Fish eat algae, which has concentrated the methylmercury. **Methylmercury** moves up the food chain from fish to birds, mammals and humans.

The spent ore from the furnaces is called **calcines**. The calcines contain small amounts of **cinnabar, mercuric oxide**, and micro-droplets of liquid elemental mercury. **HgS, HgO, and Hg⁰**

An underwater volcanic ridge full of cinnabar was pushed onto the west coast by tectonic forces. **HgS**

Mercury and sulfur from Earth's mantle can combine in fractures to produce cinnabar. **HgS**

Mercury gas has been coming from the Earth's mantle and out of volcanoes for billions of years. It is stored in coal and lava. **Hg⁰**

- cinnabar, mercury sulfide **HgS**
- elemental mercury **Hg⁰**
- elemental mercury and mercuric oxide **HgO**
- methylmercury **CH₃Hg⁺**
- elemental mercury **Hg⁰**
- mercuric oxide **HgO**
- rain with mercury **Hg⁰**
- rain with mercuric oxide **HgO**

WHY IS METHYLMERCURY IN OUR FISH?

Living organisms including plants, fish, and humans concentrate methylmercury. Half of it leaves our body after several months unless more fish are eaten.

Rain contains mercuric oxide that falls into reservoirs.

Methylmercury is converted back to mercury or mercuric oxide by the sun and oxygen.



Waste from mercury ore processing, called calcines, contains residual mercury.

Natural mercury and mercury in mining waste can run off.

Big fish eat many small fish and absorb more methylmercury.

Rain water can leach mercury into local waterways.

Mercuric oxide can leach out of volcanic ash and lava beds. Hg^0

Algae concentrate methylmercury.

Fish eat algae with methylmercury.

Cinnabar erodes physically, but as a pure compound is relatively stable and essentially insoluble in water. HgS .

mercuric oxide	HgO	●
elemental mercury	Hg^0	●
cinnabar, mercury sulfide	HgS	●
methylmercury	CH_3Hg^+	●



stagnant water

bacteria



Mercury compounds are converted to methylmercury by bacteria in stagnant water.

MERCURY & COMPOUNDS OF MERCURY

Compounds of Mercury Found in New Almaden

Mercury (Hg^0) is a naturally occurring silvery liquid. A soda can full of mercury would weigh 10 pounds.

Uses:

Mercury is used in thermometers, fillings, and blood pressure gages today, but most of the mercury from New Almaden went to extract gold and silver from crushed rock. Precious metals combine with mercury.



Cinnabar (HgS) is the mineral that was mined in New Almaden to produce mercury. Cinnabar crystals are ruby red but not very hard. When heated to over 1,000°F, cinnabar separates to mercury vapor, and sulfur gas.

Uses:

Native Americans used it as body paint. The **vermillion** powder is mixed with laquer to make Chinese carvings.



Mercuric oxide (HgO) is a rare ionic compound. Mercury vapor is combined with oxygen in sunlight.

Some mercuric oxide was produced in the furnaces in New Almaden. It is found in the burnt ore (calcines) that are buried in the park.

Uses:

Mercuric oxide is used to manufacture red-orange paint. It is also used in batteries.



Methylmercury (Ch_3Hg^+) is naturally made in very small quantities by bacteria in stagnant (oxygen-deprived) water. Man-made methylmercury was first seen as an industrial waste product from the production of plastics. When ingested, methylmercury binds to proteins in fish. The higher in the food chain and the longer a fish lives, the greater the concentration of methylmercury can build in its system. This is why humans are cautioned against eating fish from mercury-contaminated waters.

Uses: Seed grain shippers used a pink solution of methylmercury to prevent early germination, and as a fungicide.



Famous Man-Made Compounds of Mercury NOT Naturally Found in New Almaden

Mercury nitrate ($\text{Hg}(\text{NO}_3)_2$) or “mad hatters poison” was used in making hats. It was absorbed through the skin, causing drooling, shaking, and tipsy walking.



Calomel (Hg_2Cl_2) was used as a toothpaste, a purgative, a diuretic, a skin lightener, and as a cure for syphilis. It causes a burning, itching rash.



Mercury fulminate ($\text{Hg}(\text{ONC})_2$) is highly explosive. It is used to make fuses for bullets and bombs.



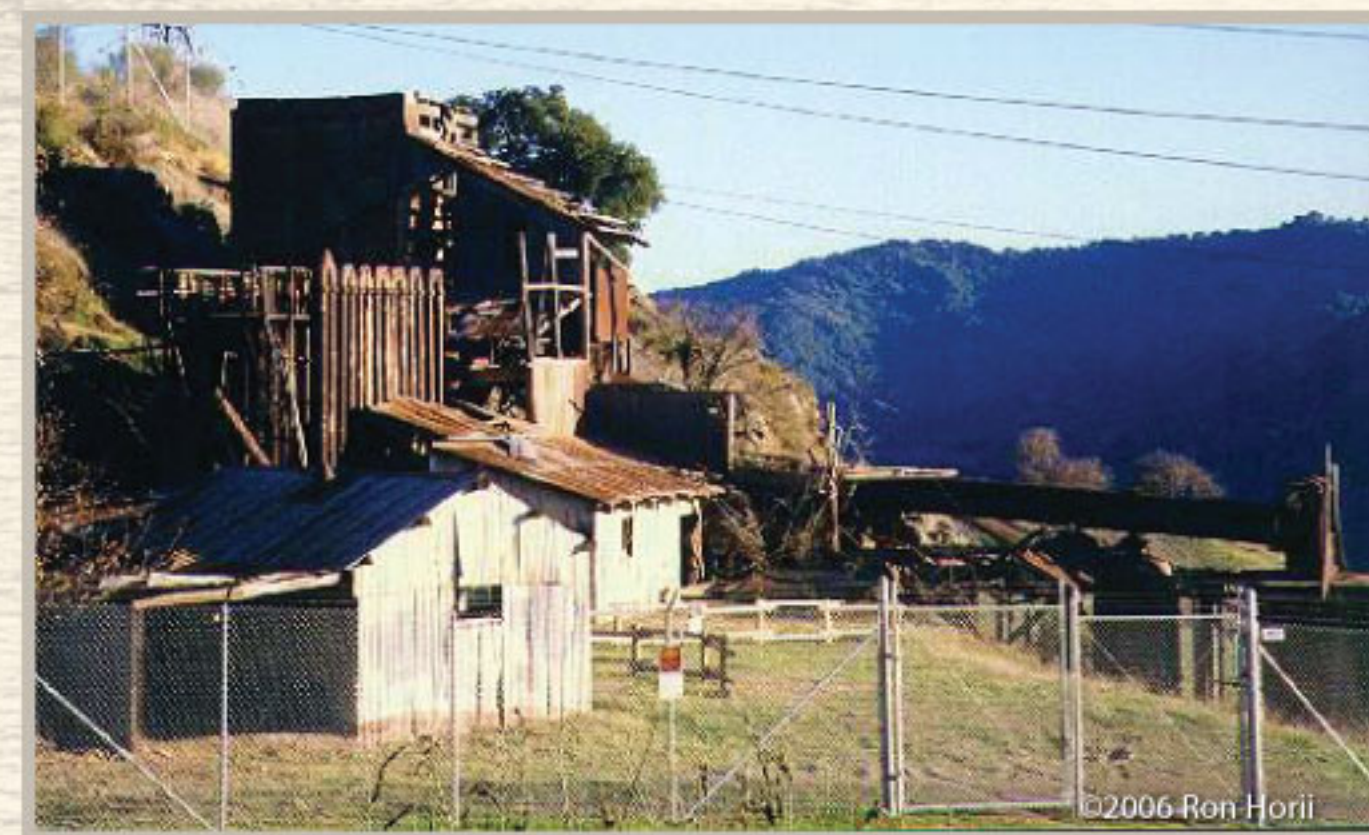
Why Are Mercury and Its Compounds a Concern?

Harm to people and the environment depends on factors such as form of the mercury chemical, route of exposure, and the dose. Depending on factors of exposure, mercury can affect the human nervous system and harm the brain, heart, kidneys, lungs, and immune system. In general, methylmercury is of most concern and is highly studied. The most common way that people are exposed to mercury is by eating fish or shellfish from contaminated waters.

What Can You Do to Reduce the Amount of Mercury in Our Lakes and Streams?

You can prevent potential mercury releases and exposure by:

- carefully handling and storing products that contain mercury, such as fluorescent lights or mercury thermometers;
- following EPA, State, and/or local health agency recommendations when cleaning up mercury spills;
- following EPA, State, and/or local agency recommendations to recycle or safely dispose of products that contain mercury;
- conserving electrical energy, so less mercury-containing fossils fuels are burned;
- supporting reasonable pollution control laws designed to reduce mercury emissions; and,
- preventing soil erosion in areas known to contain elevated mercury, such as in former mercury mining districts. The Santa Clara Valley Water District has information regarding watershed protection.

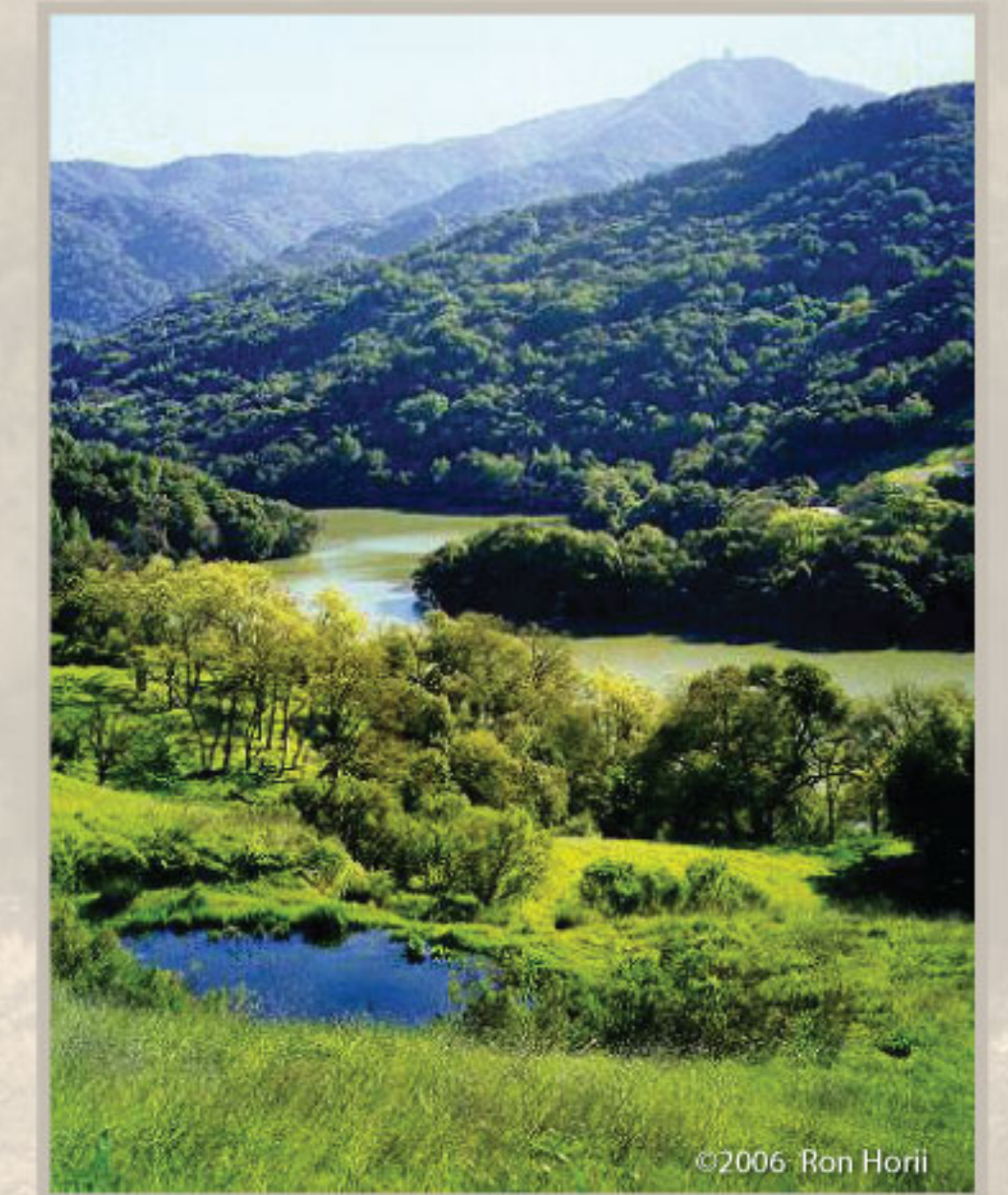


Mine Hill rotary furnace.

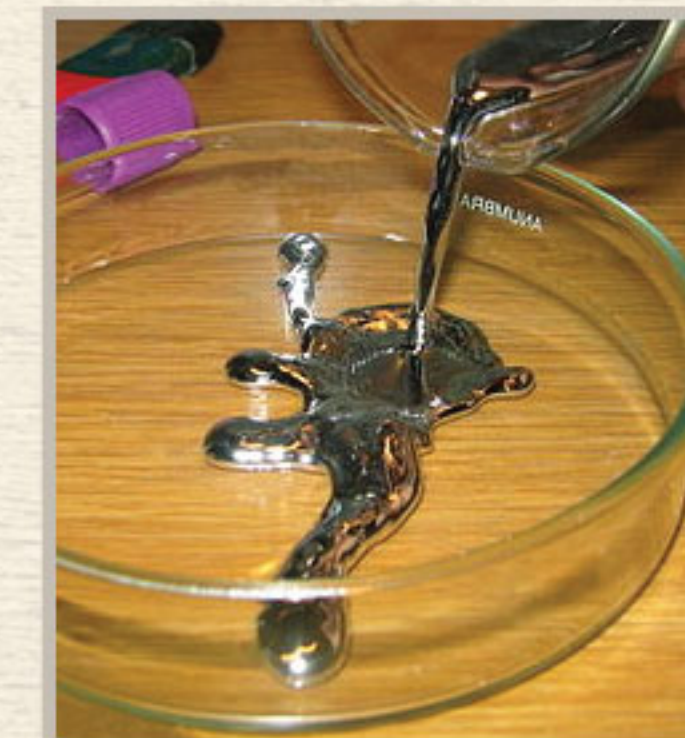
What is Being Done in the Guadalupe River Watershed by Local Agencies to Control Mercury?

The Guadalupe River Total Maximum Daily Load (TMDL) program, regulated by the U.S. EPA and the California Regional Water Quality Control Board, is being implemented by the Santa Clara Valley Water District, County of Santa Clara, and other public and private entities. The TMDL has driven actions such as:

- removal and capping of wastes from mercury mine sites and along watershed drainages;
- circulation and management of the chemistry of water in lakes and reservoirs; and,
- prevention and control of soil erosion in areas of naturally elevated mercury concentrations.



Guadalupe Reservoir.



Mercury (Hg^0).



Cinnabar (HgS).

What Methods Are Used to Control Mining Waste Discharge in the Watershed?

Soil and Erosion Control

Restoration

Calcines are waste left over from processing cinnabar in furnaces. They contain small amounts of cinnabar, mercuric oxide, and elemental mercury.

During major winter storms, calcine waste is pushed down stream by high flows of storm water. This continued eroding process cuts through the old calcine streambed deposits and pushes calcine waste further down stream. In New Almaden, some calcine deposits were removed and stream banks were restored to a natural landscape.

Calcine cliff in Jacques Gulch

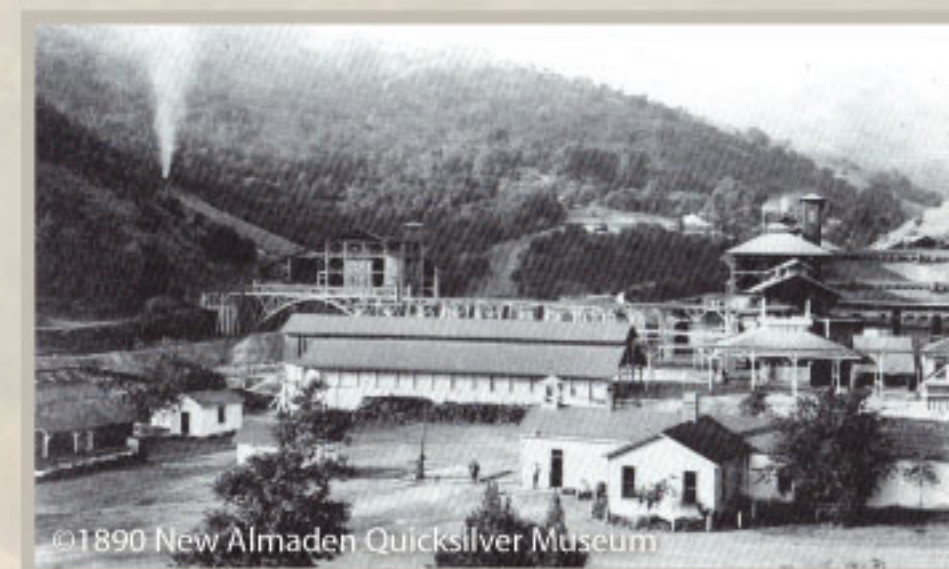


Before



After

Capping



The furnaces used at the Hacienda de Beneficio in the 1890's produced calcines.

Cinnabar ore, liquid mercury, and waste rock (calcines) were all spilled here during mining operations. Early in mine history, calcines were used to firm up muddy roads around the area as clean fill. The Hacienda calcine deposits and building bricks were removed and buried on Mine Hill, and the mining operation waste was covered by a clay cap as a federal environmental remediation project.

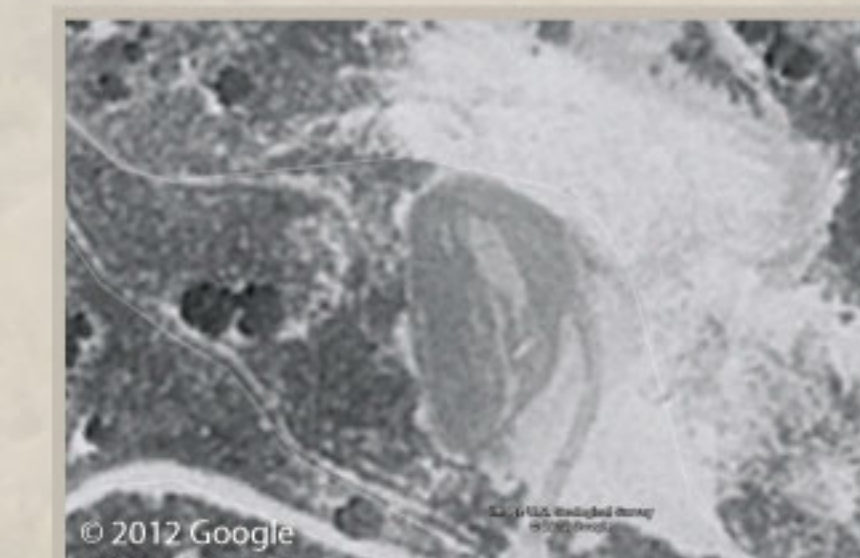
This photo shows the same reduction site in 2012. In the late 1990's, after mining waste was removed, the Hacienda field was capped with three feet of clay.



The Hacienda Furnace Yard site in 2012.

Removal

San Francisco Open Cut



Before removal, 1998.



After removal, 2012.

To prevent calcine waste from eroding into the streams from the Hacienda site, calcine waste was taken up to the top of Mine Hill's San Francisco Open Cut mine and buried in the open cut pit. Calcines from other parts of the park (Jacques Gulch) were added to the site. All the buried calcines were capped with clay.



Mine Hill, San Francisco Open Cut.

What Methods Are Used to Reduce Methylmercury in Our Lakes?

Solar Water Circulators



Water circulator in Almaden Reservoir.

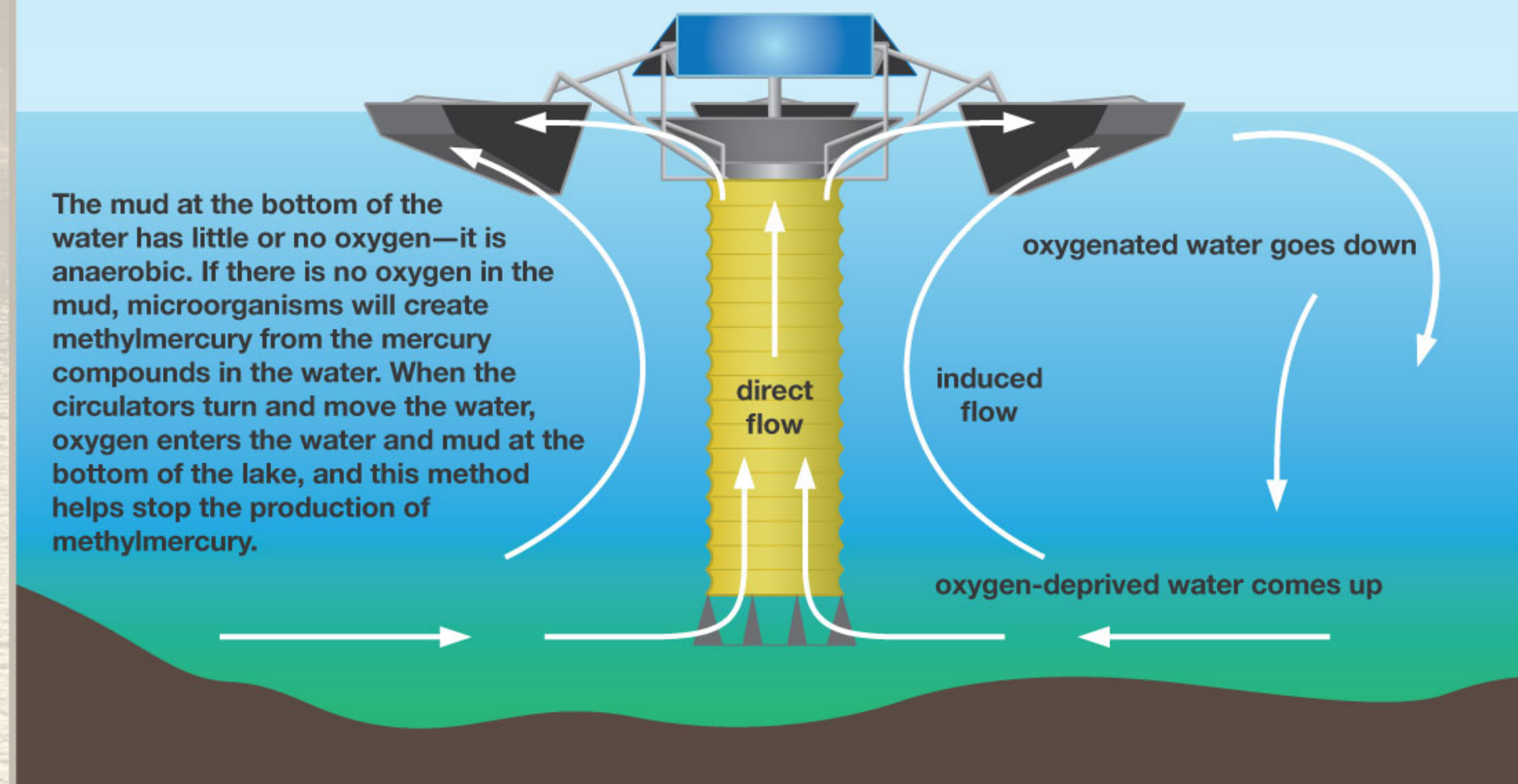
Aeration



Aeration system in Calero Reservoir.

Methylmercury is Reduced in Almaden Reservoir

Solar-powered circulating devices mix oxygen into the deep areas of water. The circulating water stops the process that creates a form of mercury that harms humans by entering the food chain.



An aeration system planned for Almaden Reservoir will deliver air into the reservoir. Added air will be pumped into the reservoir using line diffusers as shown. This will help prevent the production of methylmercury in the water.

