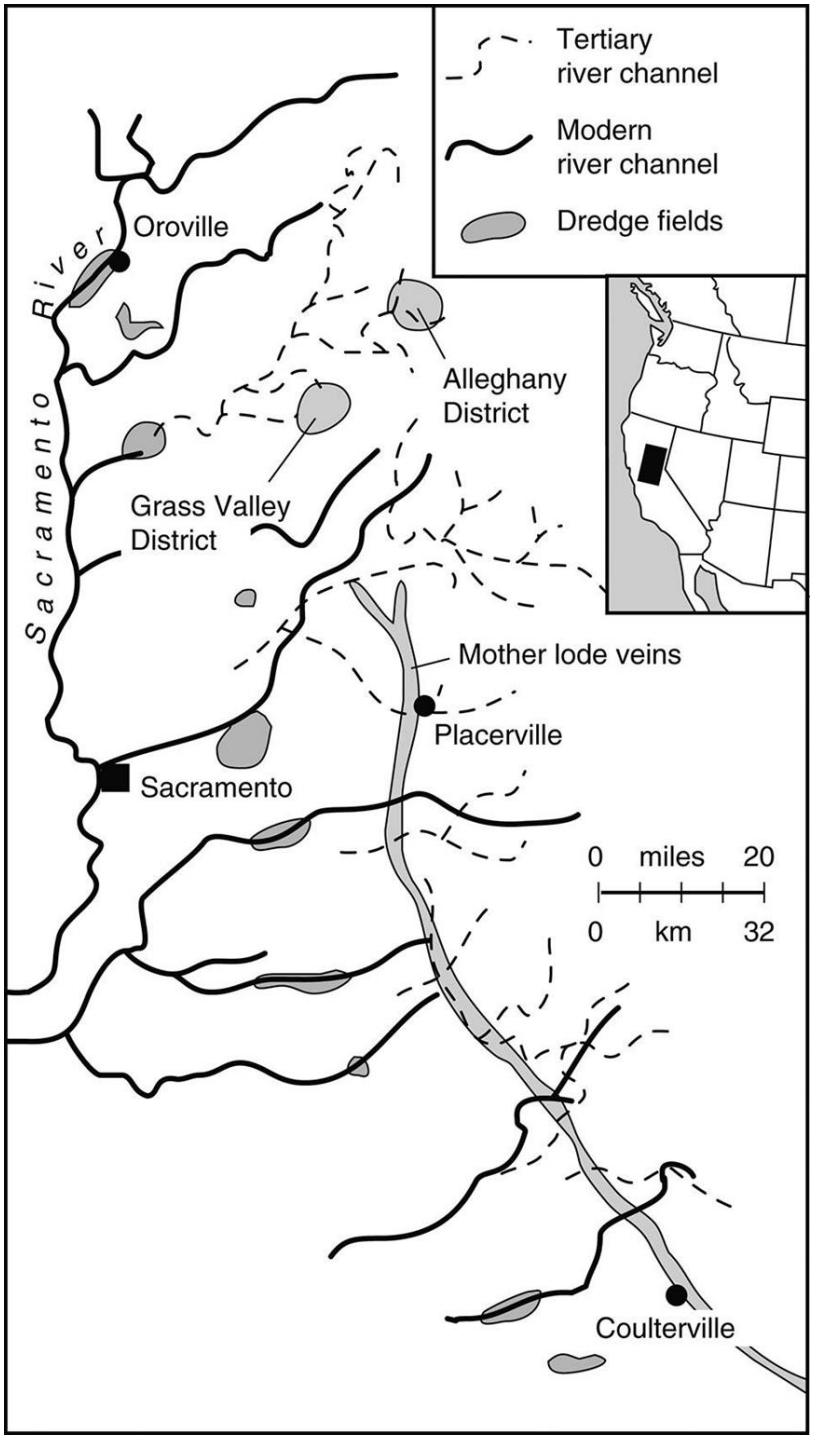
Panning for gold

Mercury Amalgamation



Amalgamation

- "Patio Process" mix ore with mercury (Hg) to dissolve gold, then heat to vaporize Hg, leaving behind gold
- Mercury bioaccumulates in fish and humans ("mad hatter")
- Hydraulic mining resulted in the 1883 California Debris Commission Act
- Still used by 10-15 million "artisanal" miners in Brazil, Ghana, Thailand, etc, releasing 100 million tonnes into the environment annually. Compare this to 10 million lbs released during California "Gold Rush"

Mercury

▶ Mercury thermostat switch. When the mercury rises to the level of the second contact wire, the circuit is closed.

LIQUID MERCURY literally drips from the walls of caves in the ancient mines at Almadén, Spain. How magical a liquid metal must have seemed, when no framework existed to understand it or place it in context!

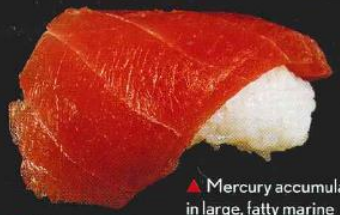
Oh piffle, mercury is every bit as magical today, no matter how much you know about it. And the more you have, the more magical it gets. I've got enough to fill a salad bowl, which lets me float a small cannonball or (wearing rubber gloves) feel the incredible pressure on my fingers plunged a few inches down into it. Even lead (82) will float on mercury—it's incredibly dense, the first thing you notice when you pick up a bottle of it. People who have a lot more, such as the miners at Almadén, can float themselves on it: A person trying to take a bath in a pool of mercury sinks in just a few inches, practically sitting on the surface.

But is a liquid metal really such a surprising thing? After all, if you get any metal hot enough, it turns liquid. That's why you can cast lead or iron (26) in molds. Mercury is actually a perfectly ordinary metal, just one that happens to be shifted into a different temperature range. Sure enough, if you cool mercury in liquid nitrogen, it turns into a tough, malleable metal quite similar to tin.

The tragic thing about mercury is how toxic it turned out to be. For thousands of years it was treated as a marvelous thing to play with, to experiment with, to use for whatever it seemed useful for. But all that time it was insidiously, slowly, and invisibly poisoning everyone who came in contact with it, damaging the central nervous system and eventually leading to madness. Mercury is the worst kind of poison—the kind you don't notice until years after the damage has been done. No wonder it took literally centuries to put the pieces together.

We now know that mercury, particularly in the form of organic compounds such as methyl mercury, gets into the food chain and stays there, collecting and concentrating in larger and larger animals until it reaches tuna fish.

The delay between exposure and symptoms kept us from noticing mercury's toxicity for hundreds of years. Thallium toxicity went unnoticed for quite a while, also, despite its much faster action.



▲ Mercury accumulates in large, fatty marine animals, like tuna.

▼ Mercury-vapor lights are highly efficient, if not the most pleasant light around.

▼ The pigment in vermillion paint is mercury sulfide.

▲ Ceramic flask for holding dental mercury. Don't drop it!

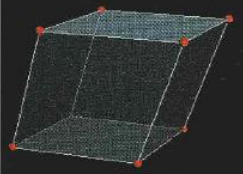
▶ A fish made of solid frozen mercury.

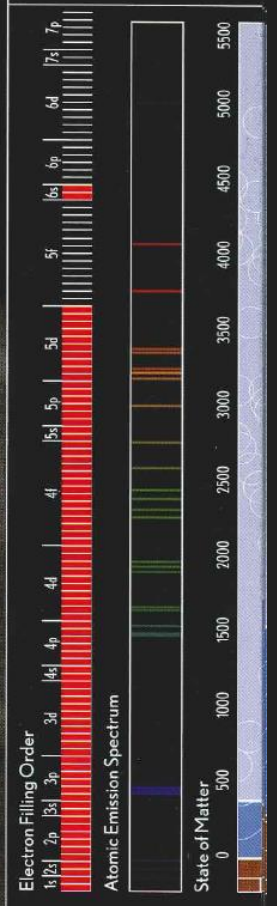
◀ A pool of mercury carefully lit and lovingly photographed by the author.

▲ Use of mercury in batteries has all but ceased due to environmental concerns.

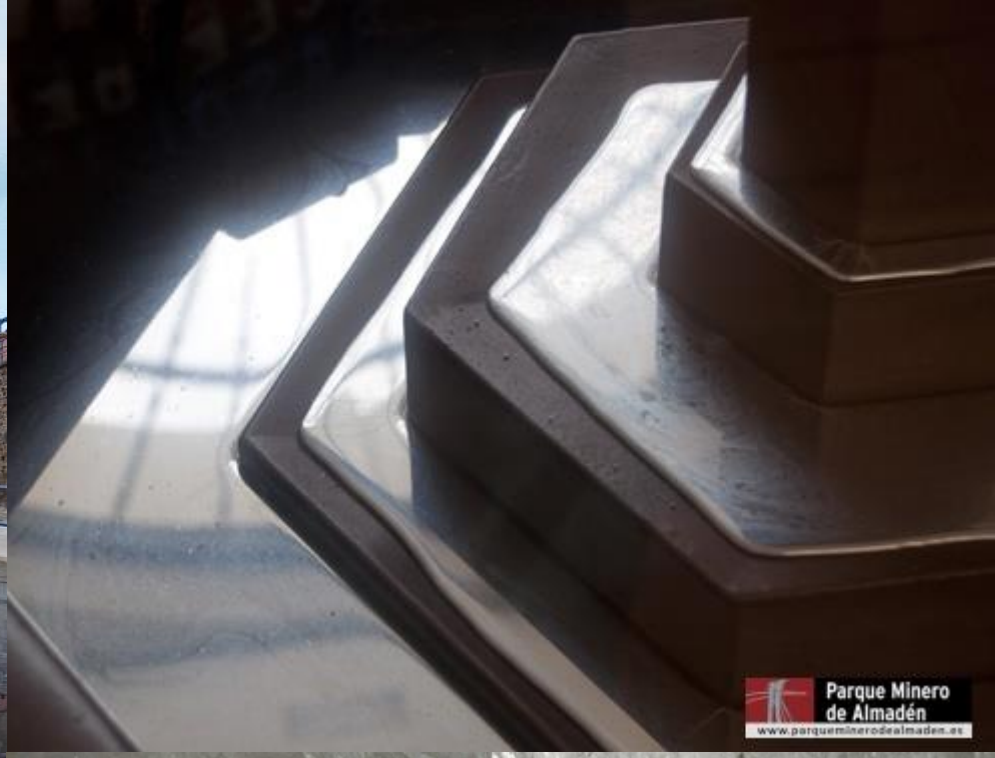
Elemental

Atomic Weight
200.59
Density
13.534
Atomic Radius
171pm
Crystal Structure



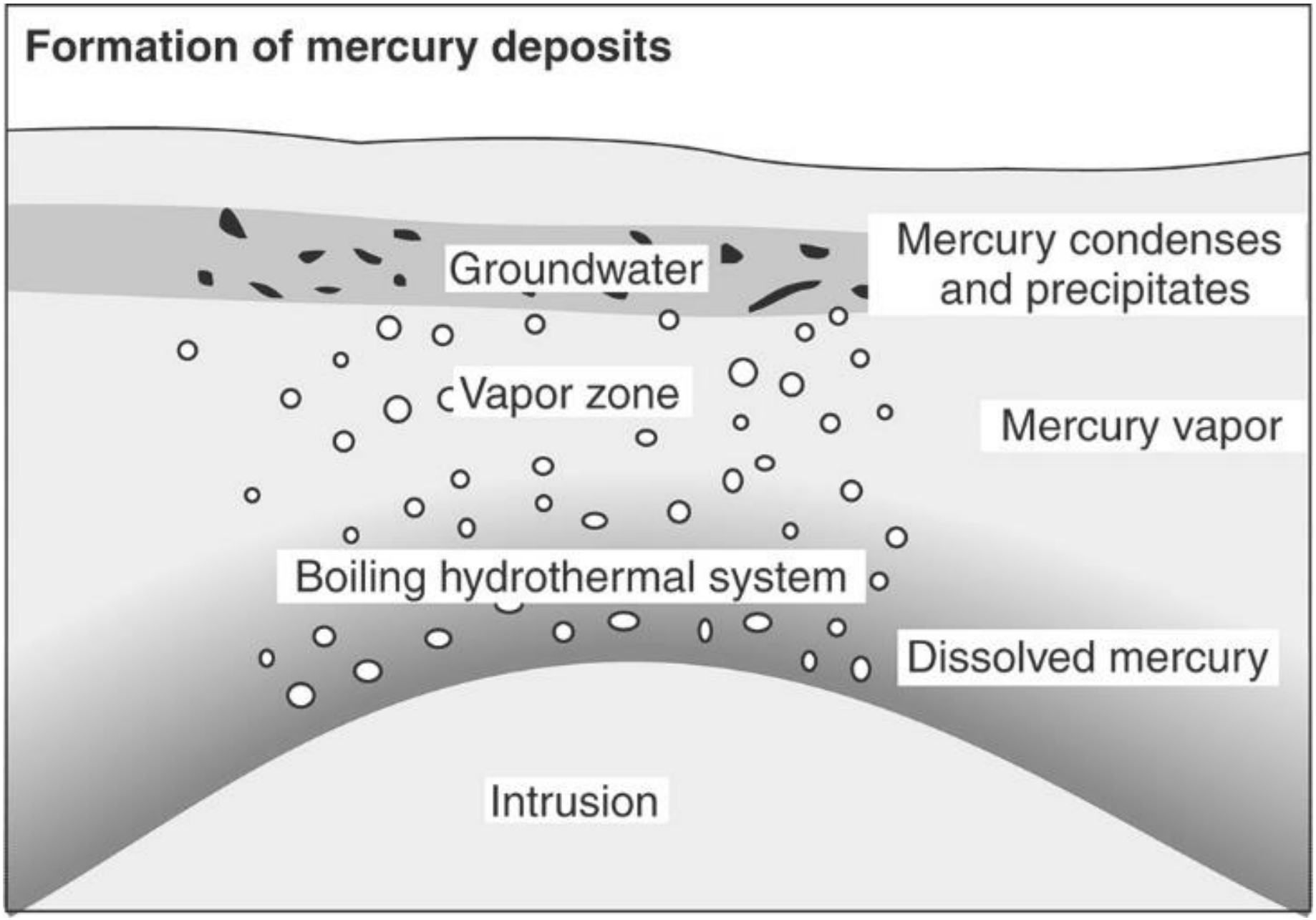


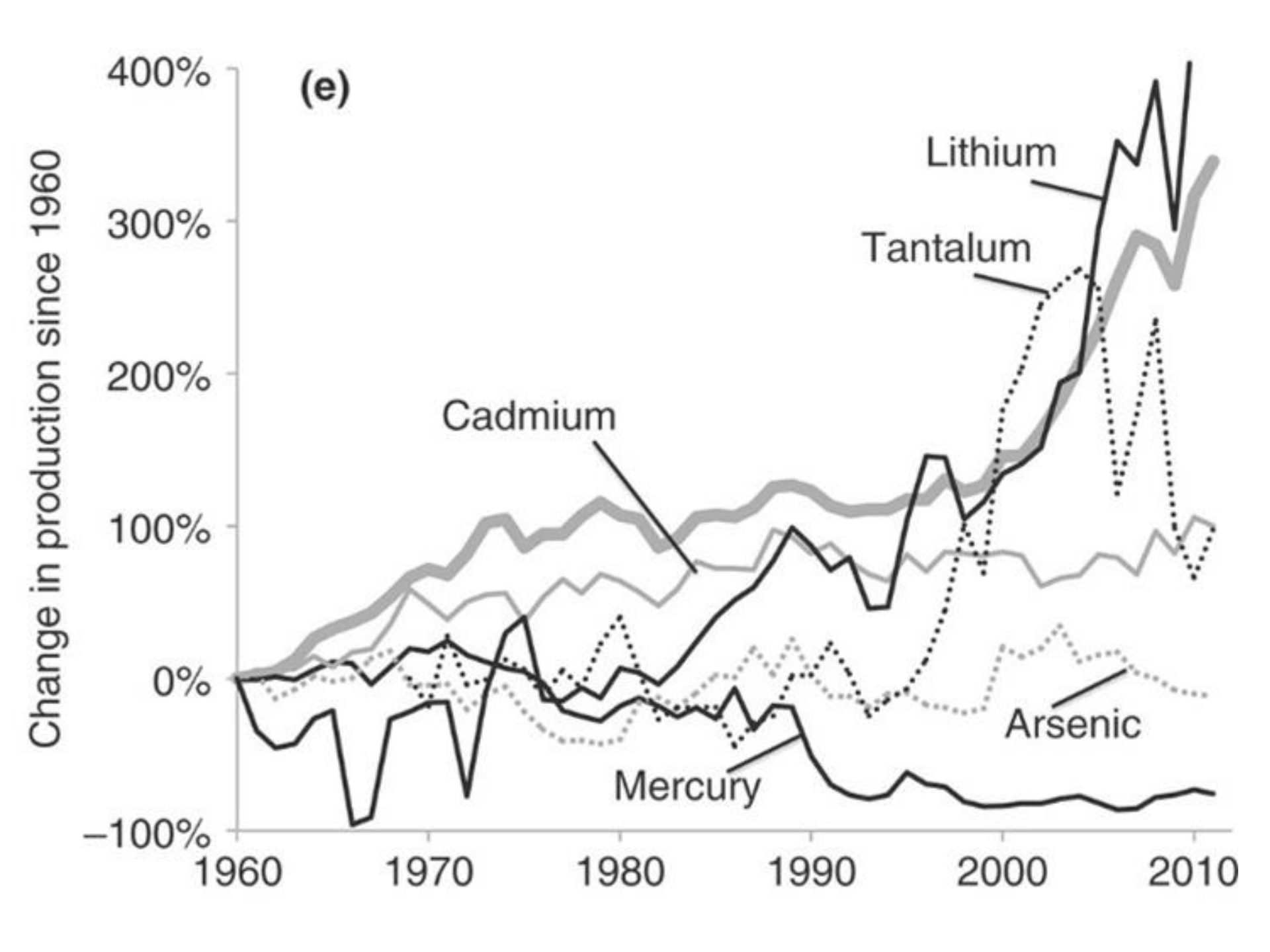

Parque Minero
de Almadén
www.parqueminerodealmaden.es

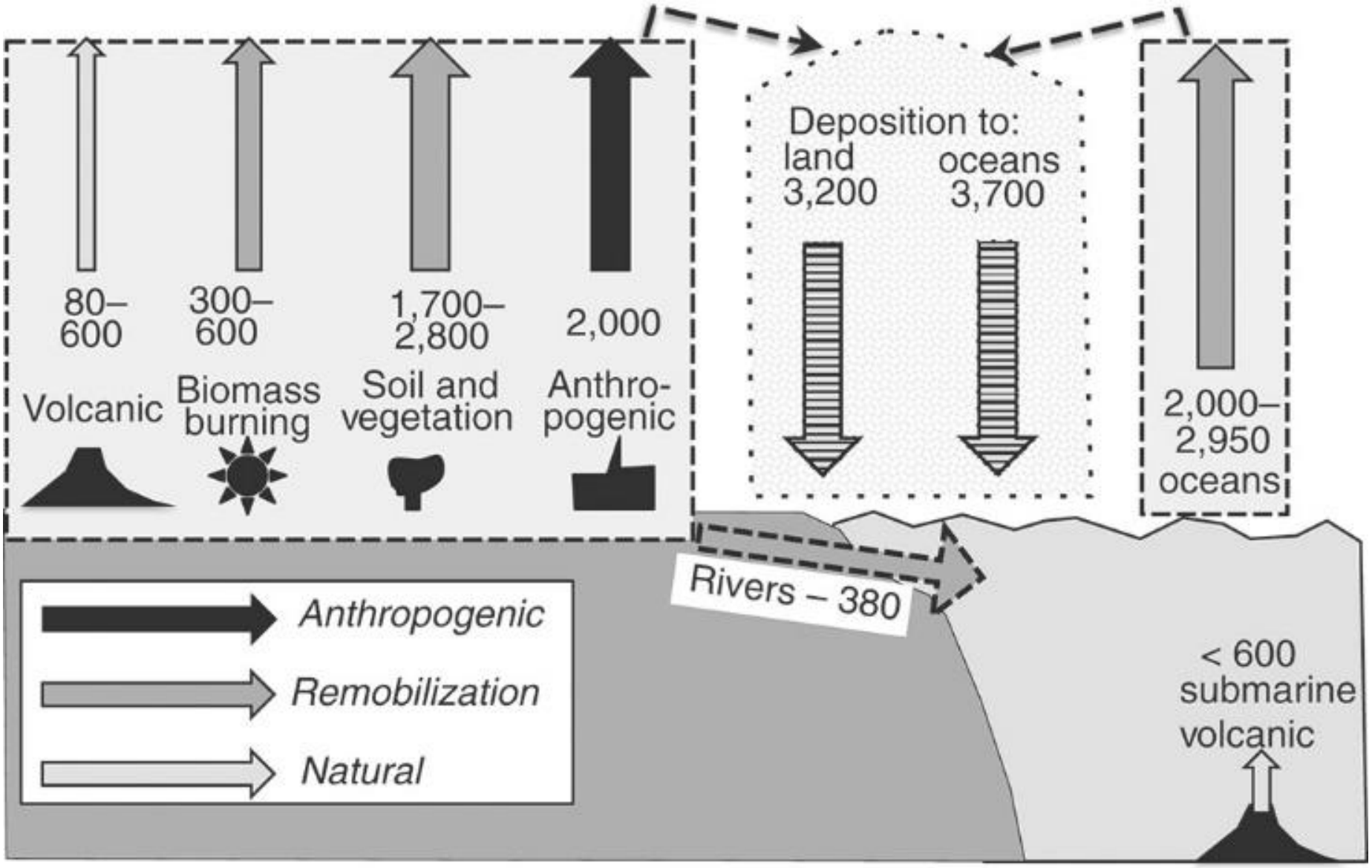

Parque Minero
de Almadén
www.parqueminerodealmaden.es


Parque Minero

- Almadén Mines is a World Heritage Site by UNESCO
- They are the largest mercury sites in the world and have been exploited since Roman times until the present day
- It is estimated that Almadén Mines has produced more than 250,000 tonnes of mercury
- Miners had to sit in hot rooms to sweat mercury out of their bodies after work


Formation of mercury deposits
Groundwater
Mercury condenses and precipitates
Vapor zone
Mercury vapor
Boiling hydrothermal system
Dissolved mercury
Intrusion


(e)
400%
300%
200%
100%
0%
−100%
Change in production since 1960
1960
1970
1980
1990
2000
2010
Lithium
Tantalum
Cadmium
Arsenic
Mercury


80–
600
300–
600
1,700–
2,800
2,000
Volcanic
Biomass
burning
Soil and
vegetation
Anthro-
pogenic
Deposition to:
land
3,200
oceans
3,700
2,000–
2,950
oceans
Rivers – 380
< 600
submarine
volcanic
Anthropogenic
Remobilization
Natural

Dental amalgam

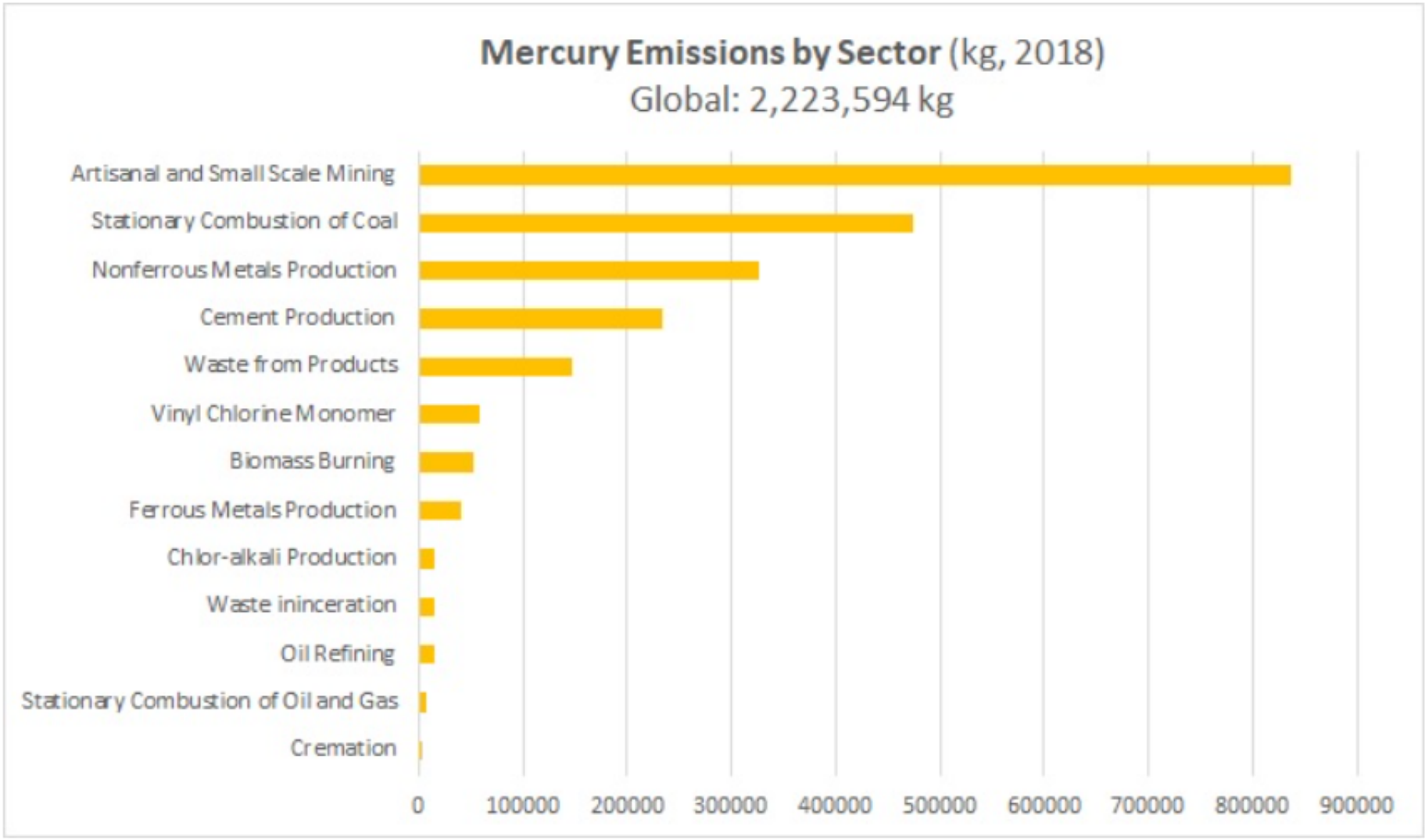
- 50% Hg (mercury), 35% Ag (silver), 12% Sn (tin)
- Cremating bodies releases it

CFL Lights

- 1 lightbulb replaced in every US household would decrease emissions equivalent to 800,000 cars
- 8 tonnes of Hg if CFL were all lightbulbs sold in USA (2014)
- If all lightbulbs were CFL and broken at the same time, ~80 tonnes would release into the environment

Vermillion Paint

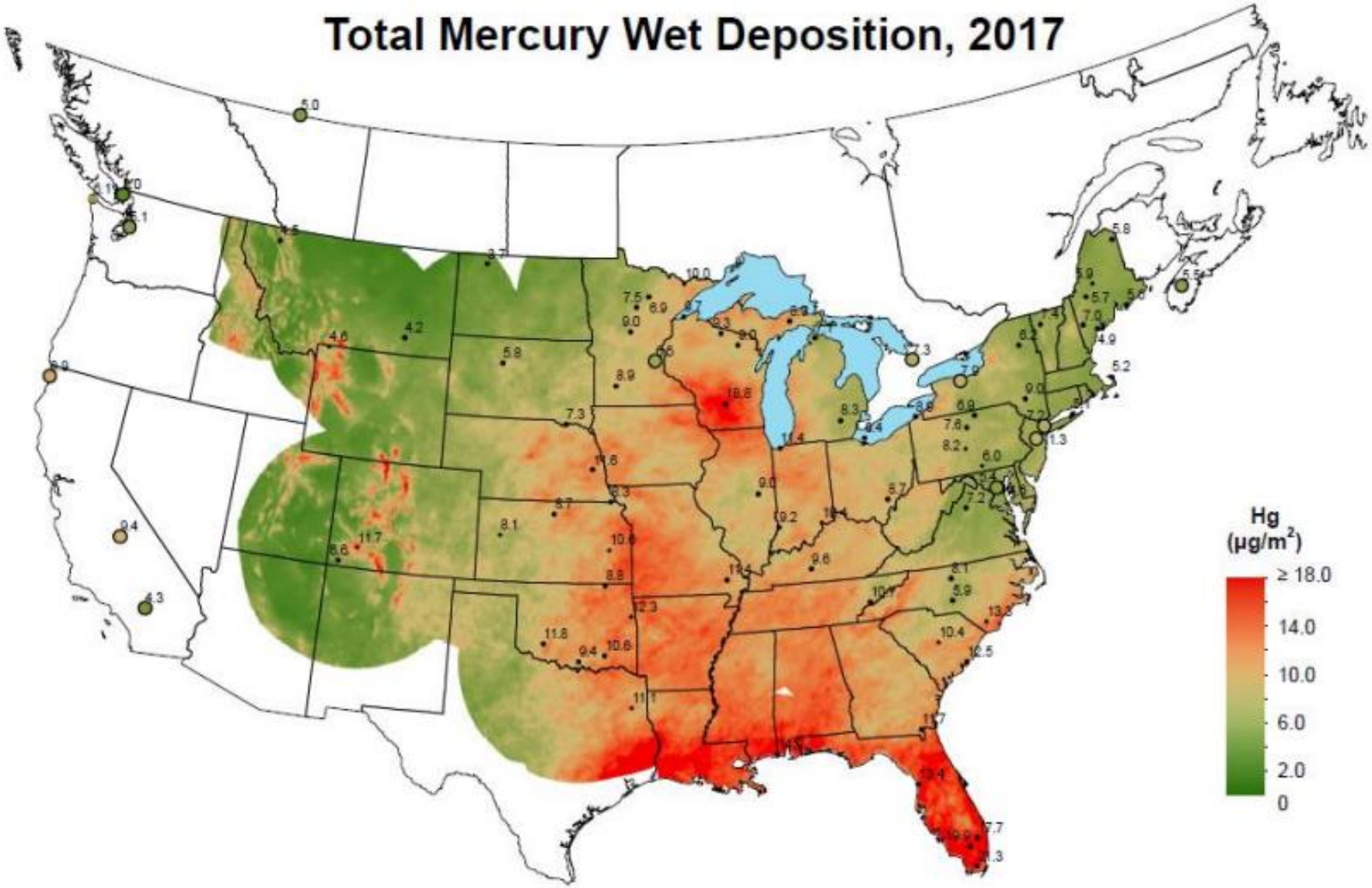
- The color was extracted from Cinnabar (HgS)
- Cremating bodies releases it



Global sources of mercury. See table for full details. Source: [Technical Background Report of the Global Mercury]

- Coal Creek Station, North Dakota
  Releases 735 lbs Hg / yr
- Due to EPA regulations, has reduced Hg emissions 40%

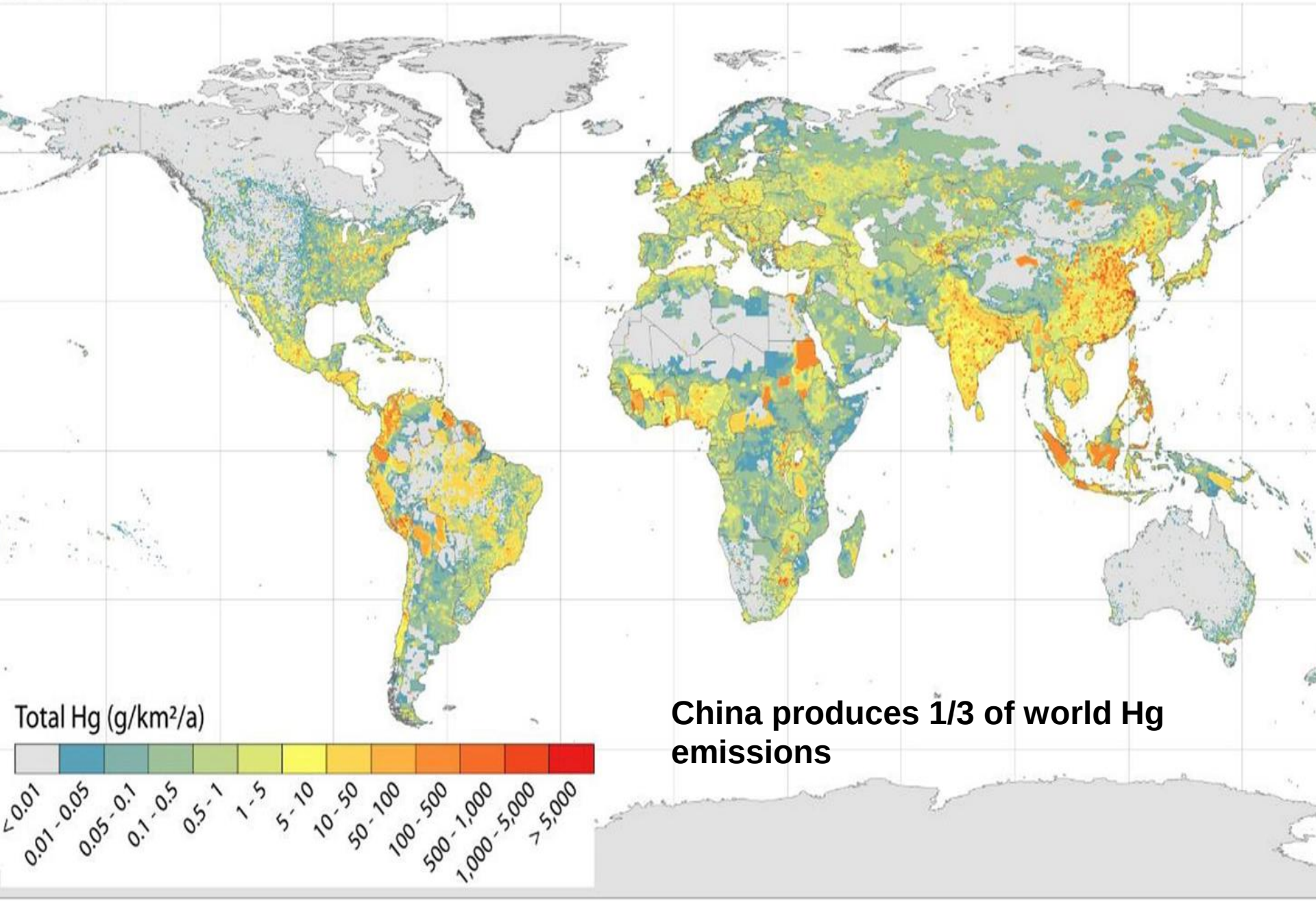
Total Mercury Wet Deposition, 2017



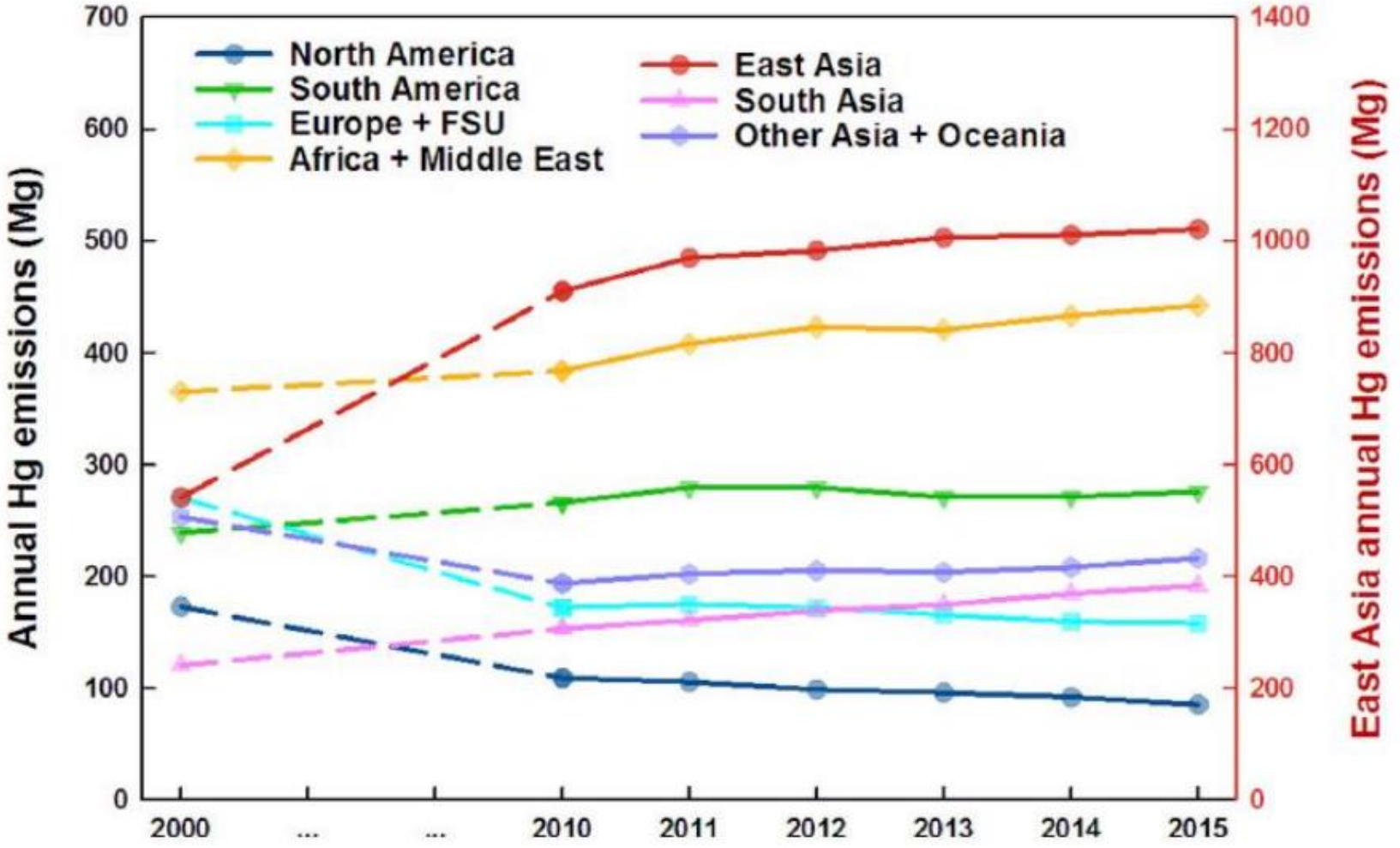
Sites not pictured:

Alaska 02	**3.8 µg/m²**
Saskatchewan 27	**4.9 µg/m²**

National Atmospheric Deposition Program/Mercury Deposition Network
http://nadp.slh.wisc.edu



China produces 1/3 of world Hg emissions



Source: Streets, D.G. et al, Global and regional trends in mercury emissions and concentrations, 2010–2015, Atmospheric Environment 201 (2019) 417–427

- Peak of 10,000 tonnes Hg production in USA in 1971
- Down to only 2,000 tonnes in 2013