

# Sources of Atmospheric Mercury

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# Big Picture: Mercury Sources

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- Natural
- Human-caused, related to:
  - Use of mercury
  - Use of materials with trace mercury
  - “Legacy” releases
    - Re-emissions of previously-emitted mercury (including through forest fires)
    - Dormant sites—old factories, mines



# Estimates of Global Mercury Emissions to Air (Mg/Year)

	Mason & Sheu, 2002	Lamborg, 2002	Seigneur, 2004
Direct human-caused	2,400	4,800	2,143
Re-emitted human-caused	2,090		2,134
Natural	2,110	1,600	2,134
Total	6,600	6,400	6,411
Natural Share	32%	25%	33%

Source: Seigneur, 2004

# Natural Mercury Releases

- Average 0.05 mg/kg in earth's crust
- Gradual release from crust to atmosphere
- Higher releases in areas of high Hg concentration
- Volcanoes
- Under sea vents



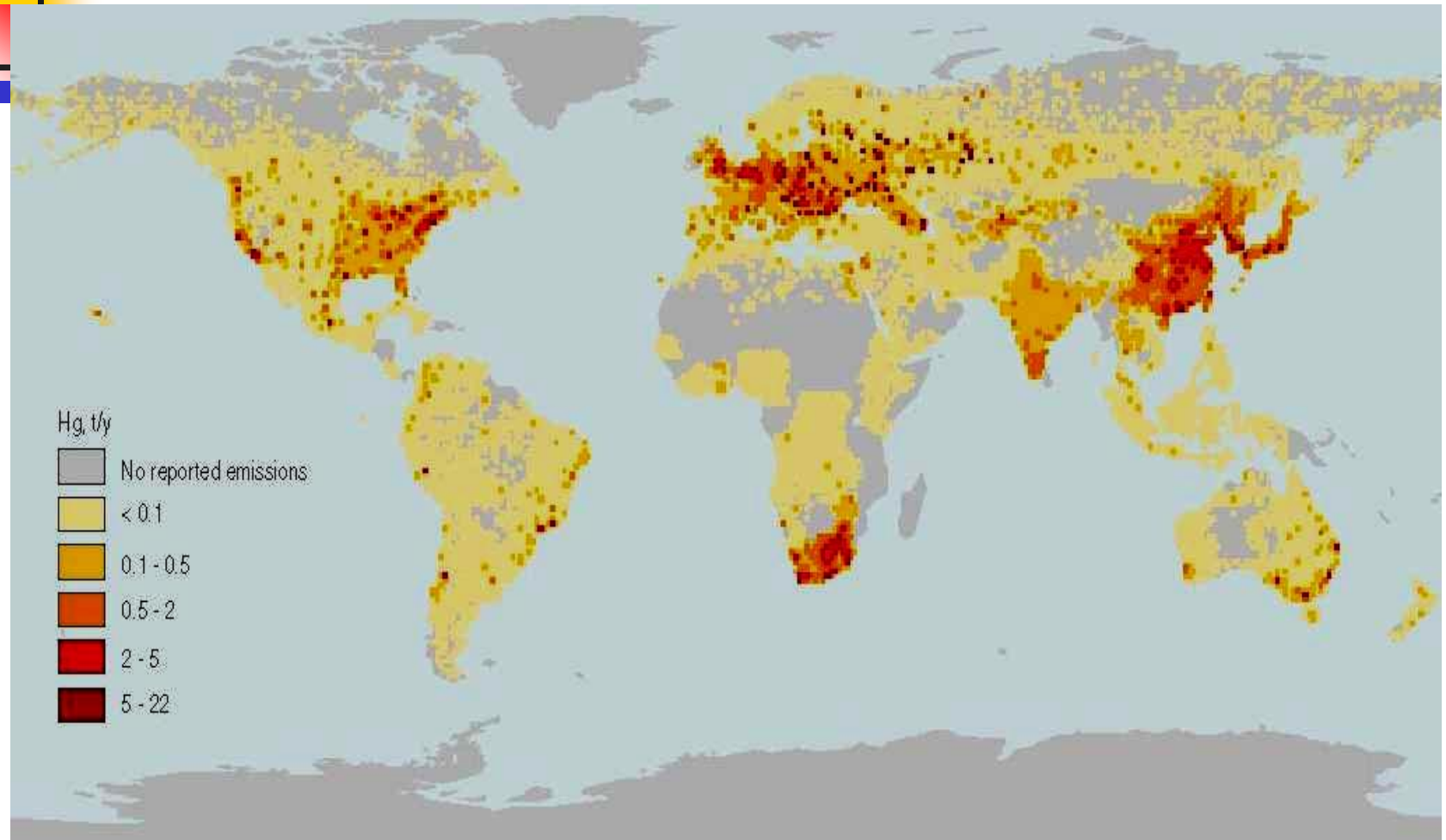


# Global Mercury Emissions: Significant Sectors

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- Fuel combustion-- especially coal
- Artisanal gold mining-- deliberate use of mercury to assist in gold recovery
- Metal smelting (from trace mercury in ore)
- Cement production (trace mercury in limestone)
- Waste disposal (from mercury in products)
- Chlor-alkali plants (production catalyst)

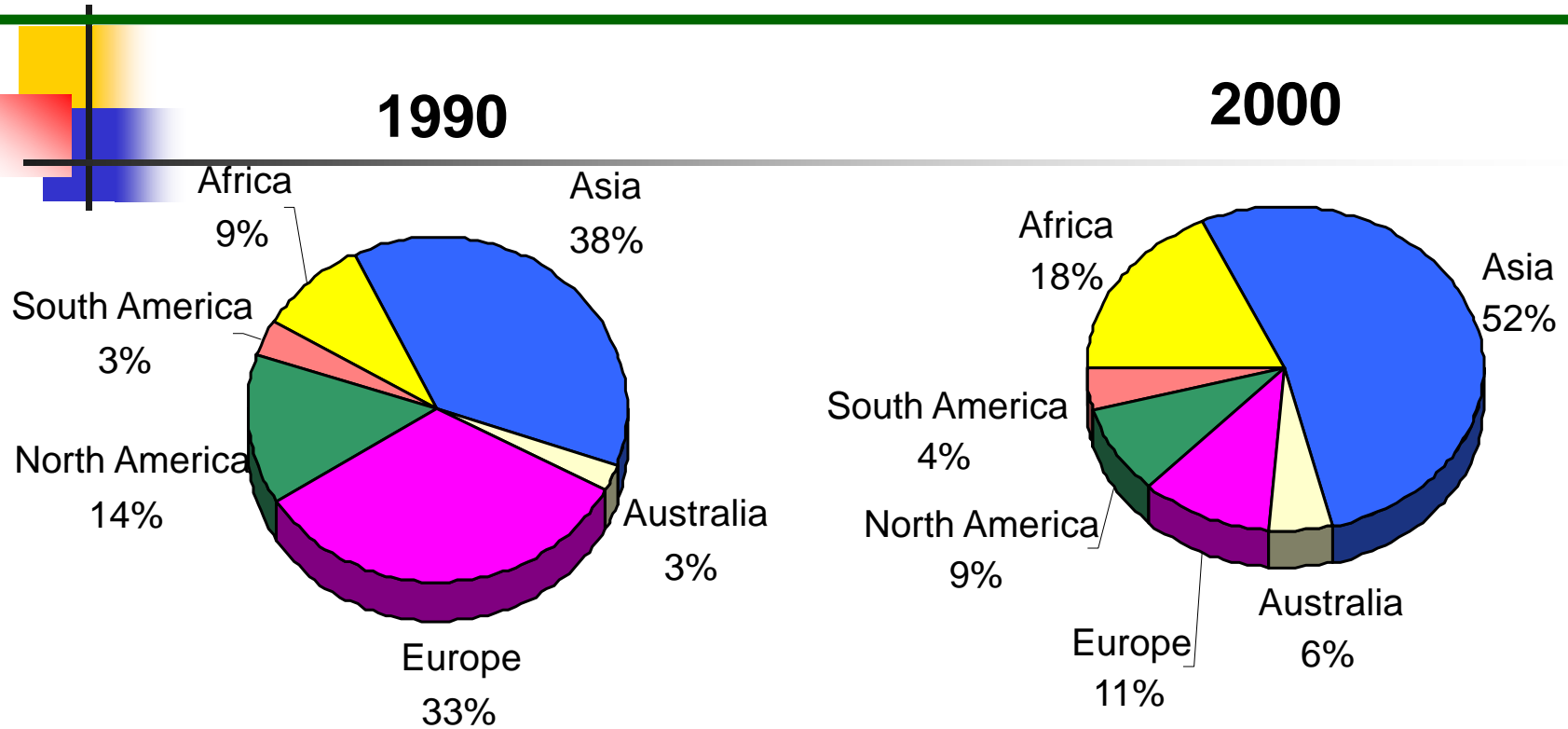
# Global Anthropogenic Mercury Emissions (1995)



Metric tons per year.

Source: United Nations Environment Programme Global Mercury Assessment, 2002, using J. Pacyna 1995 data, as presented by AMAP, 1998

# Anthropogenic Air Emissions of Mercury: Distribution by Region in 1990 and 2000



**Total: 1,881 metric tons/yr**

**Total: 2,269 metric tons/yr**

Asia and Africa account for >70% of global emissions and show steady, significant increases due to industrialization.

Source: Based on Pacyna, J., Munthe J., Presentation at Workshop on Mercury, Brussels, March 29-30, 2004



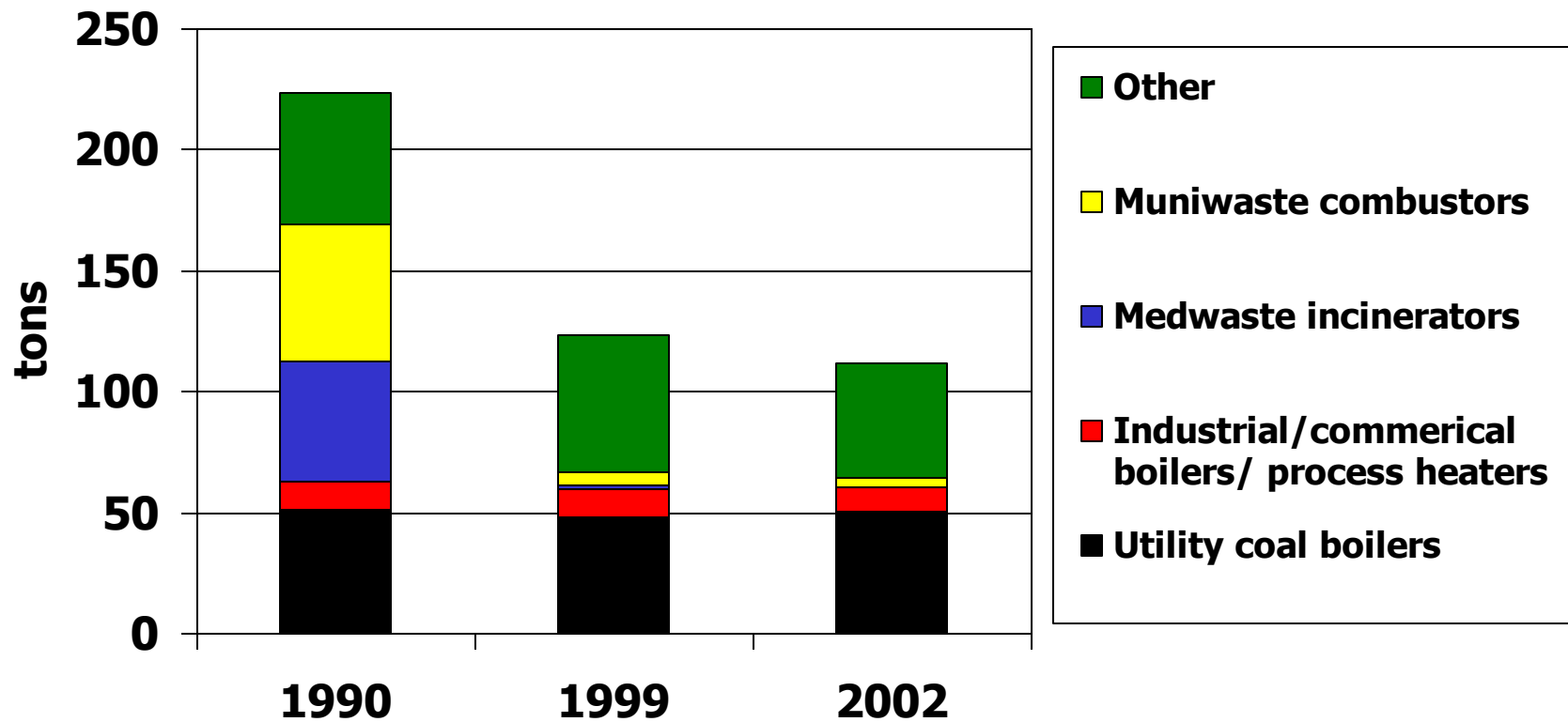
# U.S. Mercury Emissions

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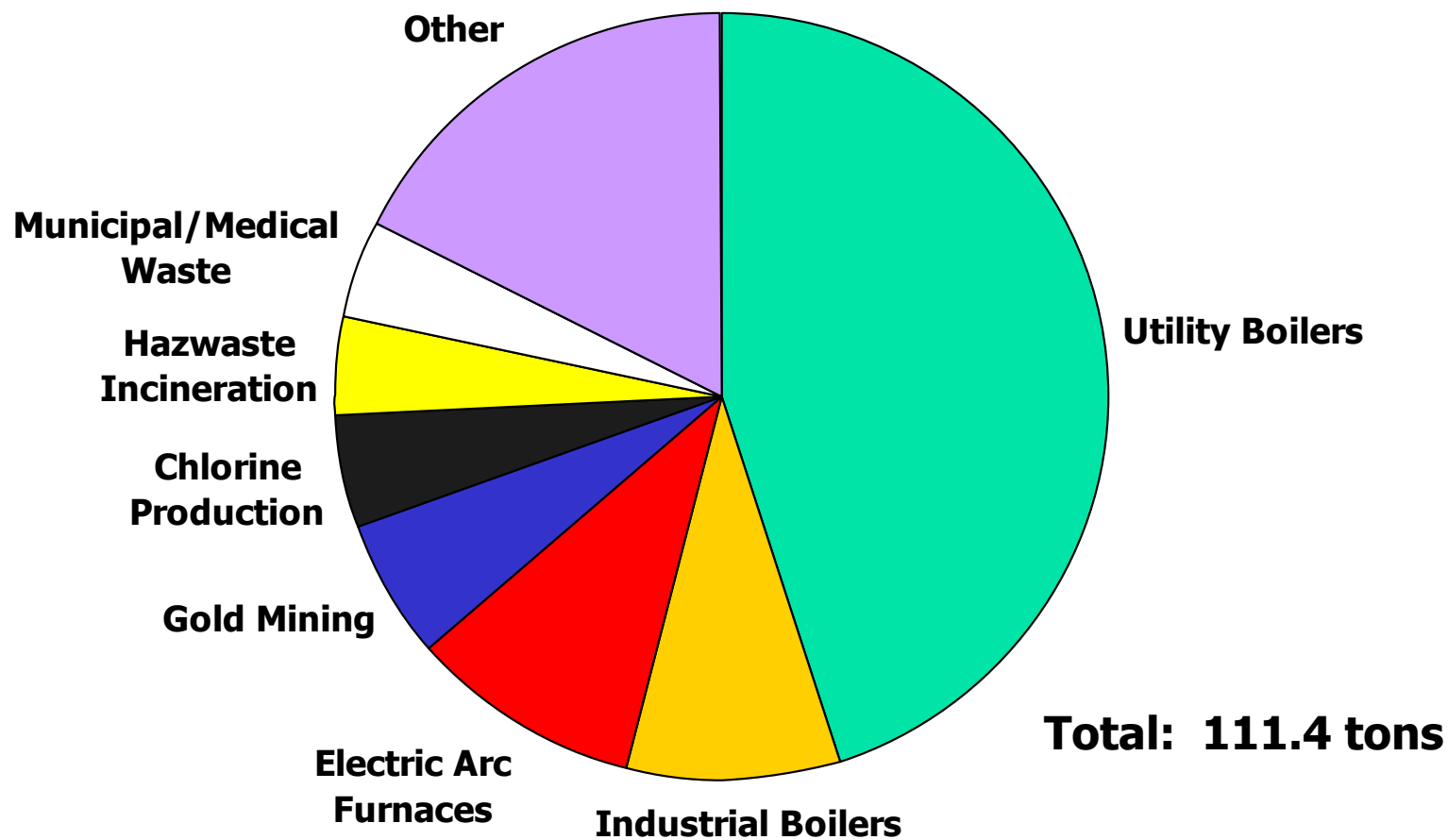
- Significant reductions (best estimate– more than 50% reduction since 1990)
- Major factor– controls on medical and municipal incinerators
- Also: reductions in mercury use– batteries, medical equipment, fungicides in paint (not reflected on inventory)
- Biggest remaining source: coal combustion



# U.S. Mercury Emissions, Trend



# U.S. Mercury Emissions, 2002





# Electric Utilities

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- Estimated 75 tons mercury in coal burned by utility power plants annually in U.S.; 48 tons emitted
- Clean Air Mercury Rule– requires states to develop regulations to meet coal-fired power plant state “budget”
- Allowance trading and banking: 38 ton cap 2010-2017; 15 tons in 2018 and beyond
- Eventual 69 percent reduction (or more if States impose more stringent requirements)



# Industrial/Commercial/Institutional Boilers & Process Heaters

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- Mercury emissions from coal and fuel oil
- MACT standard– small reduction from improved particulate control
- Potential reductions from improved boiler efficiency
- Long-term trend away from coal, towards natural gas, for residential/commercial/industrial heat
- Long-term trend away from independent power generation and towards electricity purchase



# Iron and Steel Production

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- Recycled steel contains mercury devices
  - Autos (prior to 2003)
  - Commercial appliances
  - Industrial equipment
- State laws/programs to promote auto mercury switch removal
- Rulemaking in 2006 for Electric Arc Furnaces



# Gold Mining

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- Primarily in Nevada. High mercury concentrations in gold ores
- Biggest individual sources in U.S.
- Voluntary program has led to roughly 75% emissions reduction since 2000 (process changes, control devices)
- Nevada DEP is writing the voluntary actions into regulation



# Mercury-cell Chlor-alkali Plants

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- Until recently, the biggest user of mercury in the U.S.
- Declining numbers (20 in 1990; 8 now; 2 in GL Basin)— new technology (diaphragm cell) doesn't use mercury
- Voluntary program— reduced mercury use nearly 90 percent, 1995 – 2004
- MACT standard— additional emissions reductions by 2007



# Incinerators

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- Rapid reductions in medical and municipal incinerator emissions
  - declining mercury content of waste
  - regulations requiring carbon injection
  - closure of many incinerators
- Hazardous Waste Incinerators
  - MACT standard controls based on limiting inputs of mercury-containing waste





# Cement Plants

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- Cement plants
  - fuels: hazardous waste, coal, petroleum coke
  - limestone
  - fly ash from coal-fired power plants
- Regulation
  - Portland Cement MACT: no mercury control
  - Under reconsideration: comment deadline tomorrow



# Other Mercury Sources

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- Trace contaminant of raw materials, i.e.
  - Coking coal
  - Taconite
- Continued use of Mercury-Containing Products, i.e.
  - Volatilization from broken devices
  - Cremation, dental offices
  - Burn barrels



# Mercury Product Flow Analysis

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- Based on methodology developed by Minnesota PCA and Barr Engineering
- Wisconsin DNR, Dane County, WI, and Region 5 EPA, national model of mercury releases caused by mercury containing products
- Estimated 24 tons emissions per year
  - Biggest sources: iron and steel; solid waste disposal; dental amalgam; sewage sludge disposal
  - Major decreases since 1990



# Questions?

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