Mercury Releases from Industrial Ore Processing

Great Lakes Binational Toxics Strategy

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December 6, 2005

Overview

- Background/Defining the Sector
- Estimated Global Emissions from this Sector: Relative Magnitude
- U.S. Sources
- Evidence that Significant Reductions can be Achieved by Targeting Biggest Sources

Defining the Sector: Industrial Ore Processing

- Industrial = Not small-scale (artisanal) miners
  - Artisanal miners use mercury to recover gold. By themselves one of the biggest sources
  - Industrial mining operations do not use mercury, but release it because ores contain mercury
  - Artisanal miners use mercury primarily for gold recovery. All types of industrial ore processing release mercury

Defining the Sector: Industrial Ore Processing

- Ore processing = primary metals production
  - Mining, concentrating, refining, **smelting**
  - All types of ores, but especially zinc, copper, lead, iron bauxite, gold, mercury
  - Not scrap use (i.e. electric arc furnace steel production)
- Primary metals production processes that release mercury naturally contained in ores

Estimated Global Emissions

- Previous global emissions estimates (European Union, Pacyna, Pirrone, et al: Range– 200-300 metric tons/year
- Problems
  - Limited to a few metals– zinc, copper, lead, iron. Did not include nickel, gold, bauxite, mercury, silver, manganese
  - Based on limited data, primarily from Europe– may not be representative of developing country emissions

Variability in Emissions

- Variability in mercury content of ores. Just within US:
  - gold ores--0.1 to 1000 ppm mercury
  - zinc ores--0.1 to 10 ppm
  - copper ores--0.01 to 1 ppm
- Variability in control equipment
  - Sulfur and particulate controls can reduce mercury emissions significantly (in some cases)
  - Many developing countries have no sulfur controls on smelters
- Variability in process
  - roasting processes release significant mercury
  - lower emissions from fluid bed or kiln dryer

Source: Rytuba, USGS

New Study of Mercury Emissions in China

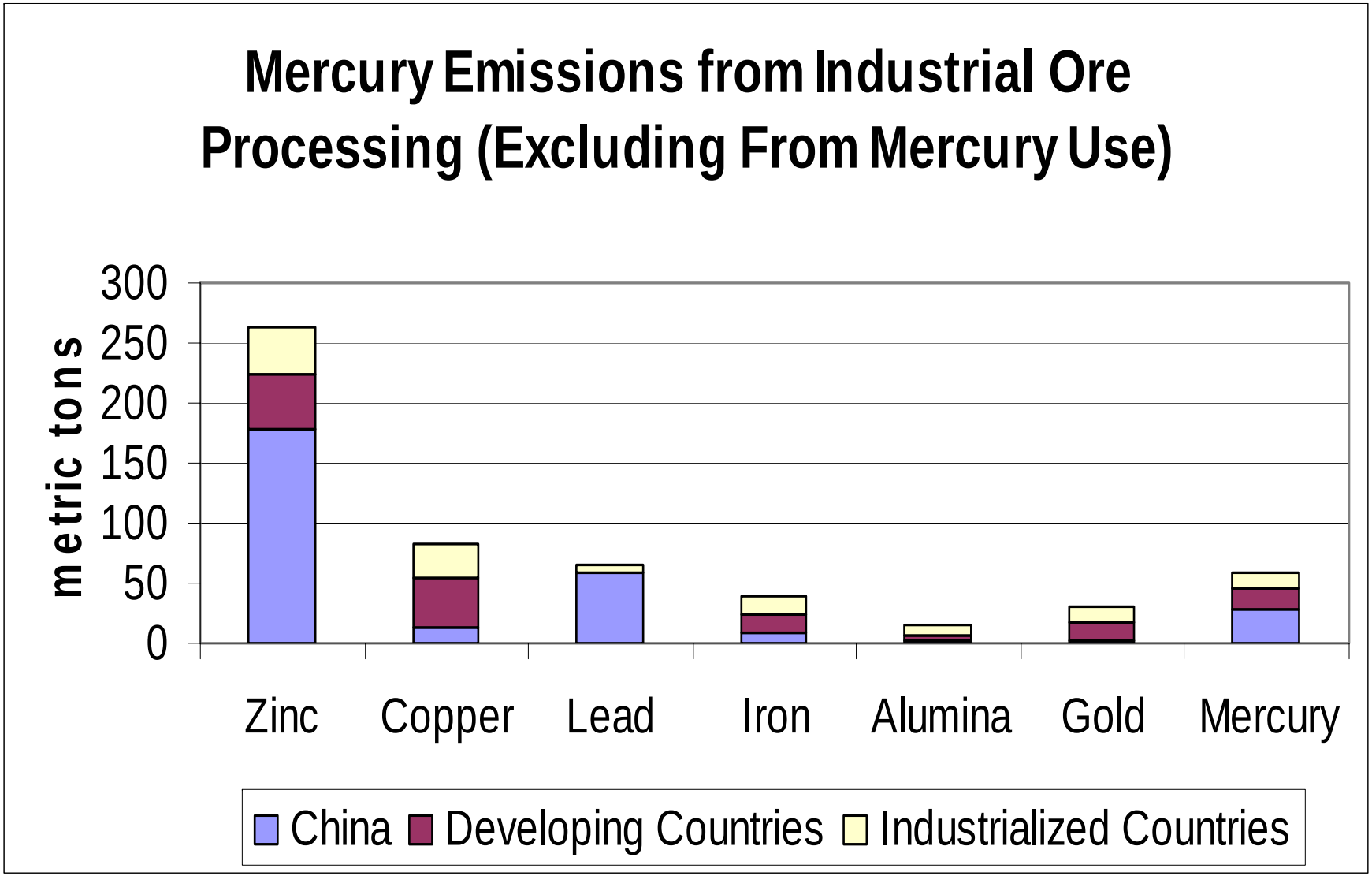
- Streets, et al, Atmospheric Environment, 2005
- Detailed data, on a level previously unavailable for developing countries
- Mercury emissions from Chinese zinc, copper and lead smelters alone– approximately 200 tons! Biggest source in China
- Because China is a major mining country, has big impact on global emissions estimate
- Raises possibility that other countries have larger emissions from this sector than previously estimated

Revised Estimate of Global Mercury Emissions from Industrial Ore Processing

- USGS production data for 2004
- For Zinc, Copper, Lead:
  - Pacyna emissions factors for industrialized countries and non-Chinese developing countries
  - Streets, et al emissions factors for China
- Iron: Pacyna emissions factors
- Bauxite/alumina: Emissions factor based on Alcoa data
- Gold: Rough estimate based on current emissions from U.S. gold producers
- Mercury: Applied Streets, et al emissions factor globally

Mercury Emissions Factors Estimates for Mining Operations (g Hg emitted per metric ton production)

	Zinc Smelt	Copper Smelt	Lead Smelt	Iron/ Steel	Alumina Refining	Gold	Mercury
Industrial Countries	**7.6**	**5.6**	**3.0**				
Developing Countries	**20.0**	**10.0**	**3.0**				
China	**86.6**	**9.6**	**43.6**				
Global				**0.04**	**0.265**	**12,100**	**45,100**


Mercury Emissions from Industrial Ore Processing (Excluding From Mercury Use)
metric tons
300
250
200
150
100
50
0
Zinc
Copper
Lead
Iron
Alumina
Gold
Mercury
China
Developing Countries
Industrialized Countries

Global Emissions Estimate

- Estimated total: 552 metric tons
- Likely range: between 360 and 725 metric tons/year
- Still much uncertainty
- Estimate does not include other ores, such as silver, nickel, manganese
- Big uncertainty about individual country estimates. But, after China, biggest emitters are Australia, Russia, Brazil, Chile, Kyrgystan, India, Japan, Spain, Canada, the United States, and Mexico
- Global Mercury Emissions from Industrial Ore Processing Operations are Significant. Larger than Previously Appreciated. Likely in the top 3 sectors

Largest Global Mercury Emissions Sources– Best Estimates (metric tons/year)	
More than 500	stationary fuel combustion artisanal mining **industrial ore processing**
100 - 500	chlorine/caustic soda production cement production waste disposal
Global total– approximately 2,000 to 2,500 metric tons/year (anthropogenic emissions)	

U.S. Sources: Great Lakes Region

- Taconite Mining– roughly 1000 pounds/year (in Minnesota and Michigan UP)
- Big River Zinc smelter, Sauget, IL, reported 579 pounds of mercury air emissions to TRI in 2003; also 1,592 pounds of land release
- Past Sources
  - Copper Mining in UP (White Pine)
  - Manganese Ferroalloys: Eramet, in Marrietta, OH. Reported 440 pounds of mercury air emissions in 2003. Since shut down.
- Future Sources?

Other U.S. Sources

- Gold mining: biggest individual sources; roughly 10 percent of 1999 inventory
- Alumina refining:
  - Alcoa, Port Comfort, TX– reported 526 pounds air emissions in 2003
  - Other alumina refining operations? Sherwin (TX), Kaiser (LA)
- Copper/zinc/lead smelters?

What Can Be Done?

- In many cases, mining emissions may be reduced significantly for relatively low cost
- Emissions highly concentrated; therefore, potentially big impact from controlling a small number of sources
  - Many operations have minimal emissions, because ore is low in mercury, low heat process are used (i.e., no roasting), or sulfur/particulate controls also reduce mercury
  - Biggest individual U.S. source– Jerritt Canyon/Queenstake gold mine– nearly 4 tons (in 2001)
  - 17 largest zinc smelters in China– estimated 107 tons – more than 6 tons per source (compared with big power plants ~ ½ ton)

Success Stories

- Nevada Gold Mines– 75 percent reduction in two years
- Canadian copper, zinc, lead and nickel smelters–
  - more than 90 percent reduction between 1990 (23.7 metric tons) and 2000 (2 metric tons)
  - Environmental source performance guidelines for base metal smelters
- Alcoa– voluntary commitment to 80 percent reduction in emissions from global bauxite refining operations, on track for implementation by 2008

Identifying the Big Sources

- Need data!
  - Mercury content of ores
  - Stack tests
  - Inventory of sources, including processes control technologies
  - Development of source-specific emissions estimates
- Need to work with Industry

What Next?

- Suggestions on how to proceed are welcomed!