Primary Smelting, Health and the Environment: the US experience

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William Paterson University of New Jersey, USA

Photo Credit: Dr. Earl Bennett, Professor of Geology and Dean Emeritus, University of Idaho
ASARCO BRAND ARSENIC TRIOXIDE 99%
FOR MANUFACTURING USE ONLY

DANGEROUS POISON
Keep Out of Reach of Children.

ANTIDOTE
GIVE A TABLESPOONFUL OF SALT IN A GLASS OF WARM WATER AND REPEAT UNTIL VOMIT FLUID IS CLEAR. THEN GIVE TWO (2) TABLESPOONFULS OF EPSOM'S OR MILK OF MAGNESIA IN WATER, AND PLENTY OF MILK AND WATER.

KEEP AWAY FROM CHILDREN, PETS, DOMESTIC ANIMALS AND WILDLIFE.

HAVE VICTIM LIE DOWN AND KEEP QUIET. CALL A PHYSICIAN IMMEDIATELY.

NET CONTENTS: 100% ARSENIC TRIOXIDE
LOT NO.: BBL. NO.
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AMERICAN SMELTING & REFINING CO.
TACOMA, WASHINGTON / 120 BROADWAY, N.Y., N.Y. 10005
Stack Emissions of Arsenic and Lead (Tons), Tacoma smelter 1953-1983


Source: M.O. Varner, ASARCO Department of Environmental Sciences to Dr. Sam Milham, Washington State health Department, Letter with Data in Attached Table, December 12, 1983
Objectives

- Describe US experience with smelter pollution, human health, and environmental impacts
  - Barriers to protecting human health
  - Regulatory, public health, and legal strategies that helped to reduce smelter emissions and children’s BLLs
Methods

- Long-term study of US smelters, interdisciplinary approach
- Historical and social science research methods
- Collection, organization and review of documents (EPA, state health departments, archives, internal company documents from lawsuits (Tacoma, Bunker Hill, Herculaneum))
- Oral history interviews
- Interviews with experts
Overview

- Lead smelter emissions chronic problem in US until closure of last primary lead smelter (Herculaneum, Missouri, 2013)
- Childhood lead poisoning near smelters not recognized until early 1970s
- No coordinated national strategy to address smelter pollution/health effects
- Federal regulation applied to all smelters, states had primary responsibility for enforcement, variable outcomes
- Lead industry very active player, delayed/diluted effective regulatory and public health response
- Children in lead smelting communities continued to have elevated BLLs even as BLLs fell in US as lead removed from gasoline
- Emissions and lead poisoning gradually reduced if concerted action taken by regulators, public health officials, public, legal system
Primary Smelting in the US

- Primary smelting industry developed in US in late 19th and early 20th century
- US was leader in primary production of lead and copper
- 1975: 7 lead smelter/refineries; 14 copper smelters
- 2014: 0 lead; 3 copper
- Industry primarily located in western US
- Pollution complaints common
- Sulfur dioxide pollution primary concern (impact on agriculture); though some concern about toxic metals early on (deaths of grazing animals)
Early Disputes 1900-1950s

- Earliest law suits over air pollution in US involved smelters
- Industry had to make some concessions: control of toxic metal emissions through baghouses & ESPs
- Industry generally resisted capture of SO₂, relied heavily on dispersion through tall stack
- Environmental impacts: acid rain, widespread heavy metal pollution
- Early research foretold extensive environmental contamination from tall stack*
- Fugitive emissions largely unacknowledged and unaddressed
- Deference to industry’s view of the problem—a nuisance, not a threat to human health
- Conflicts played out at local/state level, limited role for federal government

After World War II

- Animal deaths continued to be reported, human health concerns grow
- Change in public consciousness about air pollution
- More public discussion of sources, health effects, and demands for industry to control pollution
- Smelters central to this (disasters at Meuse Valley (1930) and Donora (1948) involved smelters)
1970: Clean Air Act, establishment of federal Environmental Protection Agency, state and regional environmental agencies
SO₂ is one of first issues; smelters under scrutiny
Federally funded survey estimated 1.9 million tons of sulfur oxides released from nonferrous smelters in 1969;
- Copper smelters recovering 19%
- Lead smelters recovering 26% *
No public source of data on lead or other toxic metal emissions

“Thus, the emission of lead into the atmosphere in the Northern Hemisphere from smelting currently is small, in comparison with the emission from burning gasoline. In 1968, for example, the comparative values were 985 tons of lead emitted from smelting and 181,000 tons from burning leaded fuels.”

“...it is only natural for persons residing close to smelters near which animals are dying of lead poisoning to be concerned about their own health. In many cases, such persons eat produce from home gardens. Analyses of blood and urine of these persons by local public health officials have not revealed evidence of increased lead absorption. It is emphasized that horses and cattle...may subsist entirely on contaminated vegetation. Probably only a small fraction of the total diet of human beings would consist of food grown in the vicinity of a lead operation. Furthermore, it is customary for people to wash garden produce (or to husk corn) before consuming it. This practice undoubtedly removes appreciable quantities of surface lead deposits. Inasmuch as the animal and human populations breathed the same air and human residents in the area did not show evidence of increased lead absorption, it may be concluded that the animals received nearly all their lead burden through oral ingestion.”
Childhood Lead Poisoning, El Paso

- Childhood lead poisoning near smelters “discovered” in El Paso 1971-1972
- Result of discovery process in lawsuit over SO2 emissions
- Toxic metal emissions found to be high (1969-1971 1100 tons Pb, 12 tons Cd, 1 ton As)
- Clinical symptoms of Pb poisoning (e.g. foot drop, lead line) documented, children hospitalized
- ASARCO tested children’s BLLs through local pediatrician (72 children >40-82, highest 94 ug/dL)
- CDC did comprehensive study of BLLs, found widespread exposure/poisoning within 4 miles of smelter (estimated 2700 children ages 1-19 with BLLs >=40 ug/dL)
- ASARCO disputed responsibility for wider lead poisoning problem and importance of on-going air emissions
- CDC/Landrigan proposed follow-up study to examine health effects, had difficulty gaining acceptance for study
- LIA and ILZRO become involved: fund competing study, find children not harmed
- CDC/Landrigan study finds kids with BLLs>40 have impaired neurological functioning
 Childhood Lead Poisoning, Bunker Hill

- September 1973 baghouse fire
- January 1974 baghouse bypass, Pb emissions increased from 37.5 tons in January to 96 tons in March; 8 tons of Cd, 800 lbs. of As
- Between 1973 and summer 1974, 720 tons of Pb emitted from stack
- CDC/State study: 919 1-9 year old children tested, 42% had BLLs between 40-79 μg/dL
- Within a mile of the smelter, 98.8% of the children had BLLs over 40 μg/dL and 38 children over 80 μg/dL.
- BLLs highest in 1-4 year olds; mean BLL in area closest to smelter was 72.5 μg/dL
- Highest BLL of 164 μg/dL in 14month-old baby

Findings at Bunker Hill

- Met with denial that children being harmed by the company and some local doctors
  - Some children were not adequately treated
  - Children continued to be highly exposed and poisoned
  - Relocated children were not tracked
- Over time, state worked with the Bunker Hill Company to deny that long-term health problems occurred, kept CDC from participating in screening/further research
Ad in local Kellogg, ID paper circa 1974 signed by Silver King PTA. Silver King Elementary School abutted the Bunker Hill smelter. Though the School Board voted to close the school, the vote was reversed by the community. In the last quarter of 1979 lead concentrations near the school measured 10 ug/m³.
Areas of contention in smelting communities

- Where is the lead coming from? Air emissions, leaded gasoline, soil, dust, paint?
- How are children being exposed? (Ingestion versus inhalation)
- Who is responsible? Industry or parents?
- Who controls blood lead screening? Who informs parents and the community of the findings?
- Who controls research on health effects?
- Best ways to reduce BLLs? (reducing emissions, education, remediation?)
- What should regulatory standards be? Should standards be tightened? Will that shut down industry?
- Who controls environmental monitoring? Where should monitors be placed?
- Who controls the narrative—is there a health threat in this community?
PRIMARY LEAD SMELTERS AND REFINERIES, UNITED STATES, 1975
Smelters at center of debate over regulating airborne lead (NAAQs)

- NRDC lawsuit forced EPA to set lead in air standard (1.5 μg/m³), set in 1978, industry given 5 yrs to comply
- St. Joe’s CEO, standard is “far more stringent than necessary to protect public health and technologically infeasible at any cost at most of the nation’s lead smelters and recycling plants.”
- Bunker Hill & El Paso closed without meeting lead NAAQs; little progress made in 1980s
- 1991: CDC lowered BLL of concern from 25 μg/dL to 10 μg/dL
- Pb NAAQs being met across US, except in smelting communities (including near refineries and secondary smelters)
- EPA “Lead Strategy” document, national plan for addressing persistent lead exposure, focus on paint, urban soils, water, Superfund sites
- Enforcement of the NAAQS could halve the number of children with BLLs over 10 μg/dL in smelting/refining communities (from 800 to 400 children), at 0.25 μg/m³ (monthly avg.), 150 children would have BLLs >10
- EPA concerned enforcement or revision of NAAQS would shut down the primary lead smelting industry
- NAAQS process time consuming and ineffective in quickly reducing exposure in smelting communities
Other Regulatory Approaches

- Superfund (CERCLA)
- Resource Conservation and Recovery Act (RCRA)
- 1990 National Emission Standards for Hazardous Air Pollutants (NESHAPs) revisions
  - NESHAPs rules for primary smelters promulgated in 1999, 2 years to comply
  - Limits on lead process and process fugitive emissions (1 lb/ton lead produced); compliance by May 2001
  - Fugitive dust control plan required*

See FR 64(107) June 4, 1999; 30194-30208
East Helena Lead Smelter Emissions 1987-2001, Tons per Year

1978 lead NAAQs achieved between 1998-1999

Source: EPA, Toxic Release Inventory, TRI Explorer
1983 SIP required paving and cleaning roads, unloading ore in enclosed building.
Listed on NPL (Superfund) in 1984; 1989 ore storage and handling moved to enclosed building;
Certain slag dumping practices ended in 1990; remediation of residential and other soils
began in 1991, focus on lowering both air and soil lead.
Herculaneum Smelter, Lead Emissions to Air 1988-2013, Fugitive, Stack and Total, Tons per Year

2008 area near smelter appears to meet 1978 NAAQS (1.5 μg/m³), out of compliance with 2008 NAAQS .15 μg/m³

Source: EPA, Toxic Release Inventory, TRI Explorer
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<thead>
<tr>
<th></th>
<th>1975 overall mean</th>
<th>1984 overall mean</th>
<th>1990s</th>
<th>2000s</th>
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<td></td>
<td>24.3</td>
<td>16.5</td>
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<td>1975 &amp; 1984 ages 1-5, range of mean BLLs by geographic quadrant</td>
<td>0-0.5 miles</td>
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<td>1992 children 6-72 months</td>
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<td>1992-1999 BLLs reported to State Health Dept.</td>
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<td>1.6% ≥ 10</td>
<td>0.8% ≥ 10</td>
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**U.S. NHANES**** geometric mean, ages 1-5 and % >10**

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2000 data reported in EPA, Responsiveness Summary, Herculaneum Smelter Site, available at [http://www.epa.gov/region7/cleanup/superfund/superfund_herculaneum_lead_smelter_mo.htm](http://www.epa.gov/region7/cleanup/superfund/superfund_herculaneum_lead_smelter_mo.htm)

2001-2002 data reported by ATSDR, Health Consultations for Herculaneum, Blood Lead Results for 2001 and 2002 Calendar Years

2007-2013 data obtained through personal communication, Jennifer Lewis (Research Analyst), Missouri Department of Health and Senior Services, June 3, 2014.

NHANES data from MMWR, Blood Lead Levels in Children Aged 1-5—United States, 1999-2010. April 5, 2013 / 62(13);245-248
More community involvement starting in late 1990s, including requests to test environmental contamination
- 2000 BLL testing by county/state found 15% of children 1.5 miles of smelter had BLLs >=10 μg/dL
- BLL surveillance conducted in 2001 & 2002, elevated BLLs found
- 2001 MDHSS called smelter “imminent and substantial endangerment” to public health
- Increased involvement of state & EPA
- State promulgated “abatement and cease and desist order”; stop using open backed trucks for hauling concentrate, decrease fugitive dust; buy 160 homes near smelter for “fair market value”, soil and interior dust clean-up
- 2007-8 enclosed concentrate unloading facility, walled concentrate storage, enclosed sinter loading, wetting roads, street sweeping, improvements to baghouses, automatic closing doors blast furnace, sinter and refinery buildings
Lessons Learned

- Childhood lead exposure/poisoning near smelters is predictable, preventable and unacceptable
- Requires vigilance: monitoring of air, soil and children’s BLLs on on-going basis
- Regulatory capture has been a problem in US
- Emissions reductions feasible; even ageing US smelters ultimately met 1.5 μg/m³ NAAQs; substantially reduced stack and fugitive emissions
- Multiple regulatory strategies and community involvement important
- Regulatory efforts alone insufficient: public health, advocacy, lawsuits important
Lessons Learned: strategies for lowering BLLs

- Relocation of residents from areas near smelters/buy-outs of property owners/renters (El Paso, Bunker Hill, Herculaneum)
- Controlling stack and fugitive emissions
- Remediation of soil and house dust
- Annual surveillance of children’s BLLs (E. Helena, Bunker Hill)
  - Universal screening or random sampling; seasonality
  - Data on children’s higher BLLs in smelting communities often motivated regulator action
  - Confidentiality and sensitivity important
  - “The mining context has been described as instilling stigmas, parental blame and a sense of shame about lead exposure and resultant health effects”*
- Health officials should control screening, lab testing and reporting of results
- Results publicly reported
- Health education on harms of childhood lead exposure and reducing exposure (not substitute for reducing and cleaning up environmental lead)
- BLL surveillance in general population; comparison data important

Lessons Learned: Environmental Standards and Monitoring

- Monitoring should be conducted/controlled by government agencies
- If industry is to monitor then agency monitors should be co-located
- Air monitoring sites should be based on knowledge of local conditions such as prevailing winds and locations of vulnerable populations (e.g. daycare, schools, child-use areas)
- Averaging time for air standards important to protect against short-term peak exposures (US standard 0.15 μg/m³ based on 3 month rolling average)
- Peak and average results should be reported to the public (e.g. available on web, communicated to the community)
Regulators should consider requiring smelting companies to offer buy-outs/relocation of families living within smelter’s zone of influence (air lead >0.15 μg/m³), particularly those with pregnant women or young children.

Schools, daycares, parks and playgrounds should be located outside of smelter-influenced zones.
Long-term health effects?

- Little to no systematic follow-up of exposed children in US smelting communities
- Limited number of health outcomes studied
- Tacoma: no long-term studies
- Bunker Hill: 20 year follow-up study of highly exposed children found more central and peripheral nervous system effects along with neuropsychiatric symptoms in adults exposed to lead as children
- Herculaneum: Study of ALS and MS found prevalence similar to US averages, noted spatial clustering of ALS near smelter
- El Paso: ATSDR found higher than expected rate of MS in children who attended one elementary school near smelter
- Almost exclusive focus on lead even though As, Cd, Hg often important smelter contaminants (As Class A multi-organ carcinogen)
Silver Valley Clean-up
30 Year Timeline
$700 million;
3190 residential and community properties have been remediated to date, soil lead >1000 ppm or arsenic > 100 ppm
2,436 yards cleaned up by EPA (arsenic over 230 ppm). Dept of Ecology is now cleaning up yards with soil arsenic >100 ppm.
**DIRT ALERT!**

For nearly 100 years the ASARCO copper smelter in north Tacoma released arsenic and lead, which are now found in our soils. Arsenic and lead are harmful to your health and children under age six are at greatest risk.

Moderate levels of arsenic have been found in small areas of Dottie Harper Park. State Ecology is working with Burien Parks to replace the soils in these areas with clean soil in Spring 2012.

Please continue to enjoy this park! Just follow these simple healthy actions to reduce your contact with soil:

- **Wash hands and toys** with soap and water after playing in the dirt.
- **Wash hands before eating** or putting anything in your mouth.
- **When you get home**, take your shoes off or use a doormat.
- **Wipe off your pet’s dirty paws**, too.

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**Soil Safety Program Work 2006 through Sept. 30, 2012**

From the [Tacoma Smelter Plume 2012 Annual Report](#)

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