Sources of Pb in Children in a Primary Zn-Pb Smelter Environment

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Location

North Lake Macquarie, NSW

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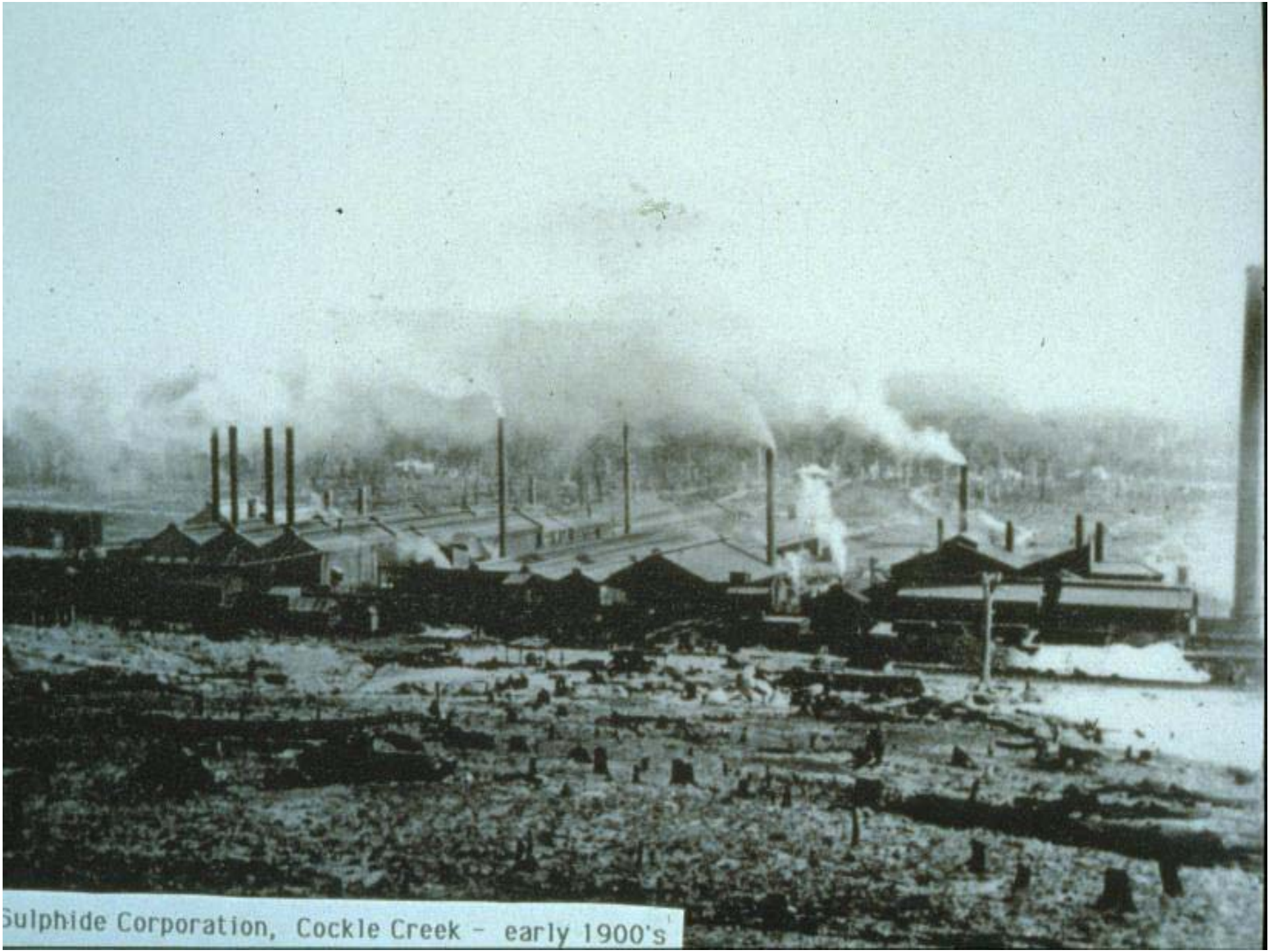
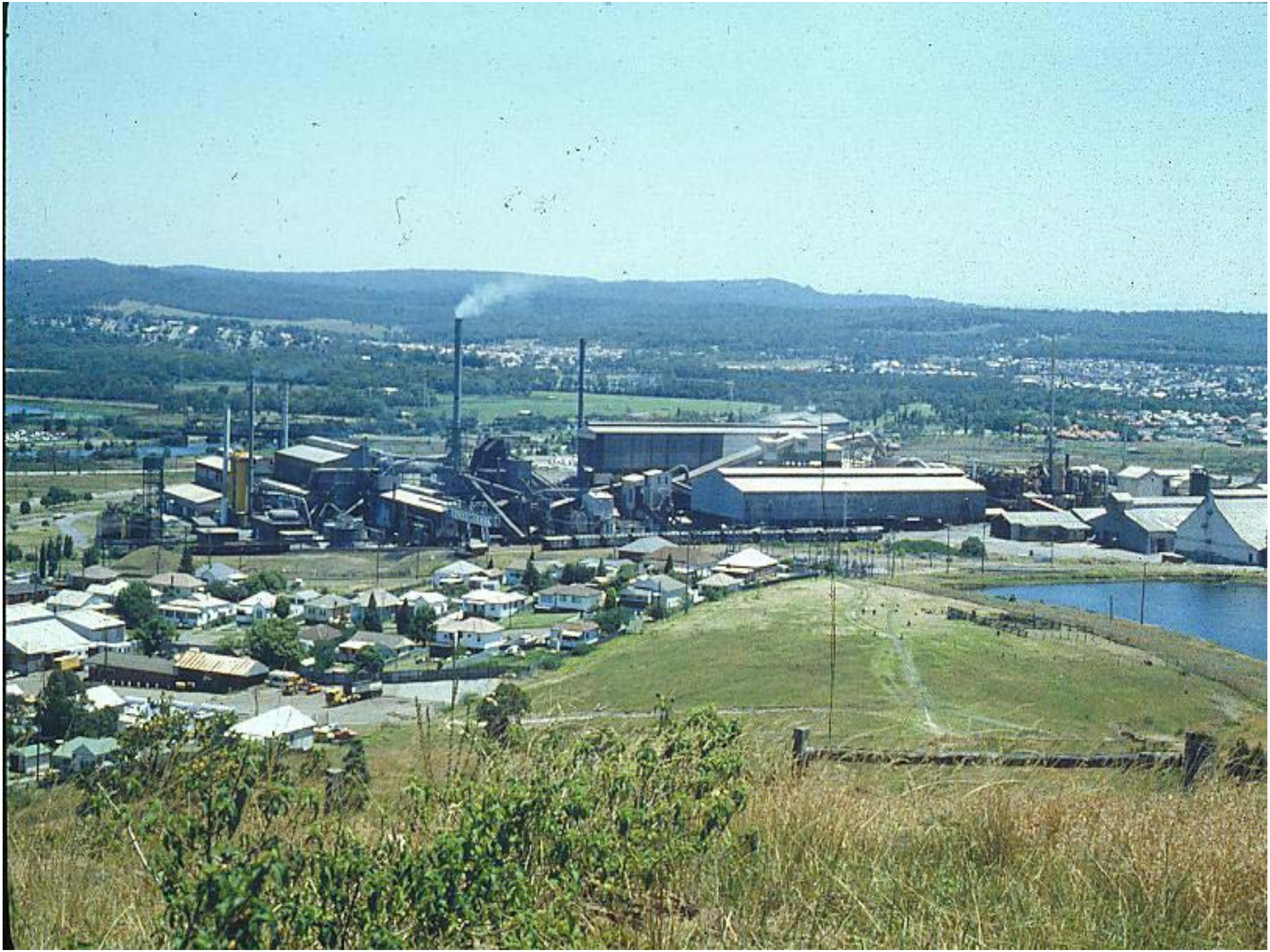
A Brief History

- 1897 – Primary Pb smelter established on the Cockle Creek site
- 1922 – Smelter closes, Zn roasting continues, product goes to EZ in Risdon, Tasmania.
- 1961 – Pb smelter reopens, continues until present
- Produces Zn, Pb and sulfuric acid as major products
- Contributes annually about $AUD50M to the local economy



Sulphide Corporation, Cockle Creek - early 1900's

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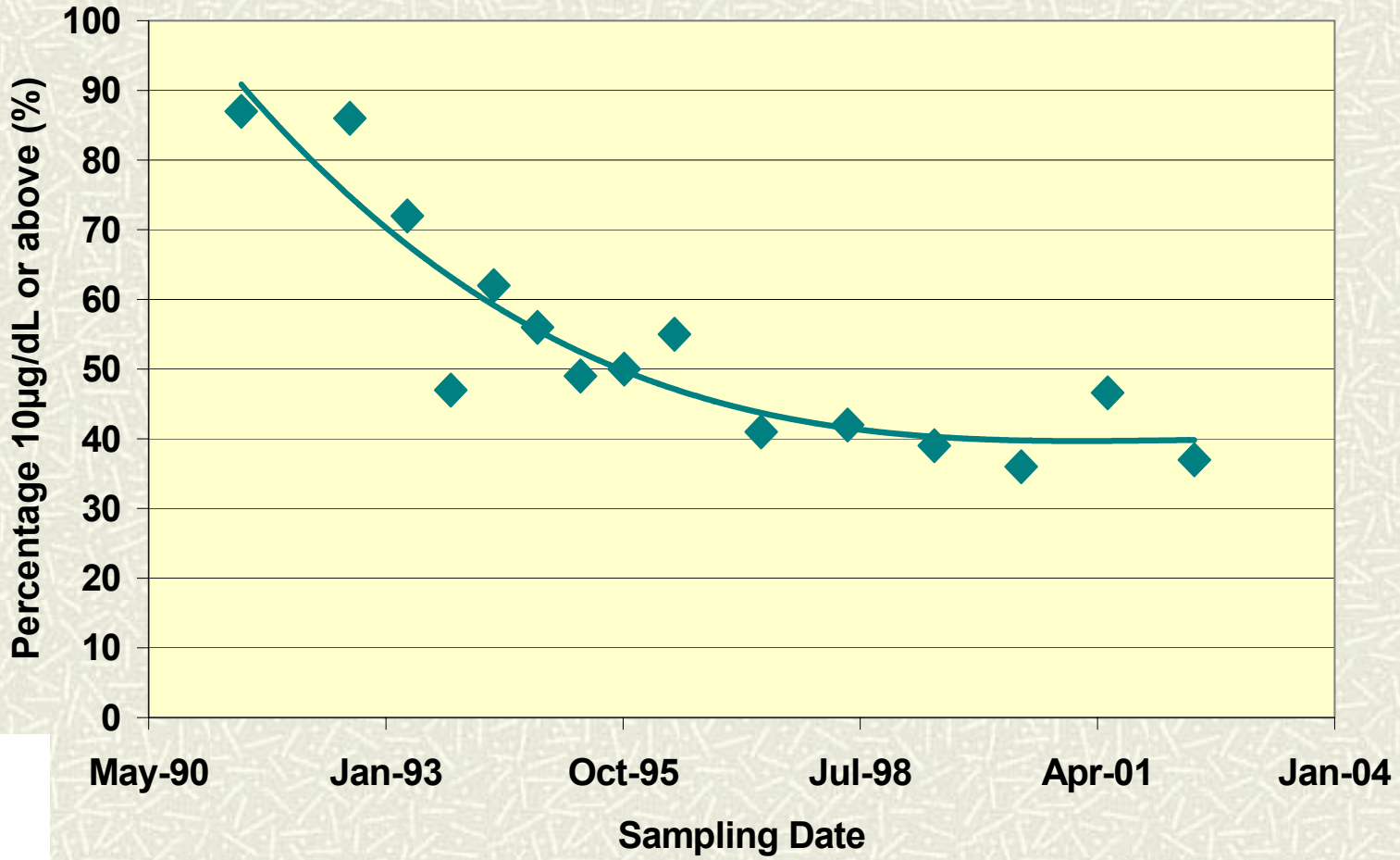
Percentage of North Lake Macquarie children under 5yrs of age with blood lead 10µg/dL or more



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Rationale – our study

- Opportunistic sampling in response to pleas for help from concerned parents whose children had elevated (blood leads) PbB from Health Department surveys and/or pediatrician
- Mothers concerned that had poisoned children during pregnancy from their own Pb load/exposure

Samples

- 6 houses – variable samples
- Dust -vacuum cleaner, surface wipes, ceiling (attic) dust, dust fall accumulation (petri dish, 3 mo collection)
- Paint
- Soils
- Deciduous teeth, blood from 2 children

Analysis

- All samples prepared in ultraclean labs at CSIRO North Ryde
- Pb concentration by isotope dilution and isotopic ratios by high precision thermal ionisation mass spectrometry

Hazard Identification for Pb - 1

Pb recognised as health hazard

- affects blood, liver, kidneys & central nervous system
- women miscarriages, abortions, stillbirths
- men low sperm counts, abnormal sperm

High levels

- motor neuropathy, encephalopathy, death

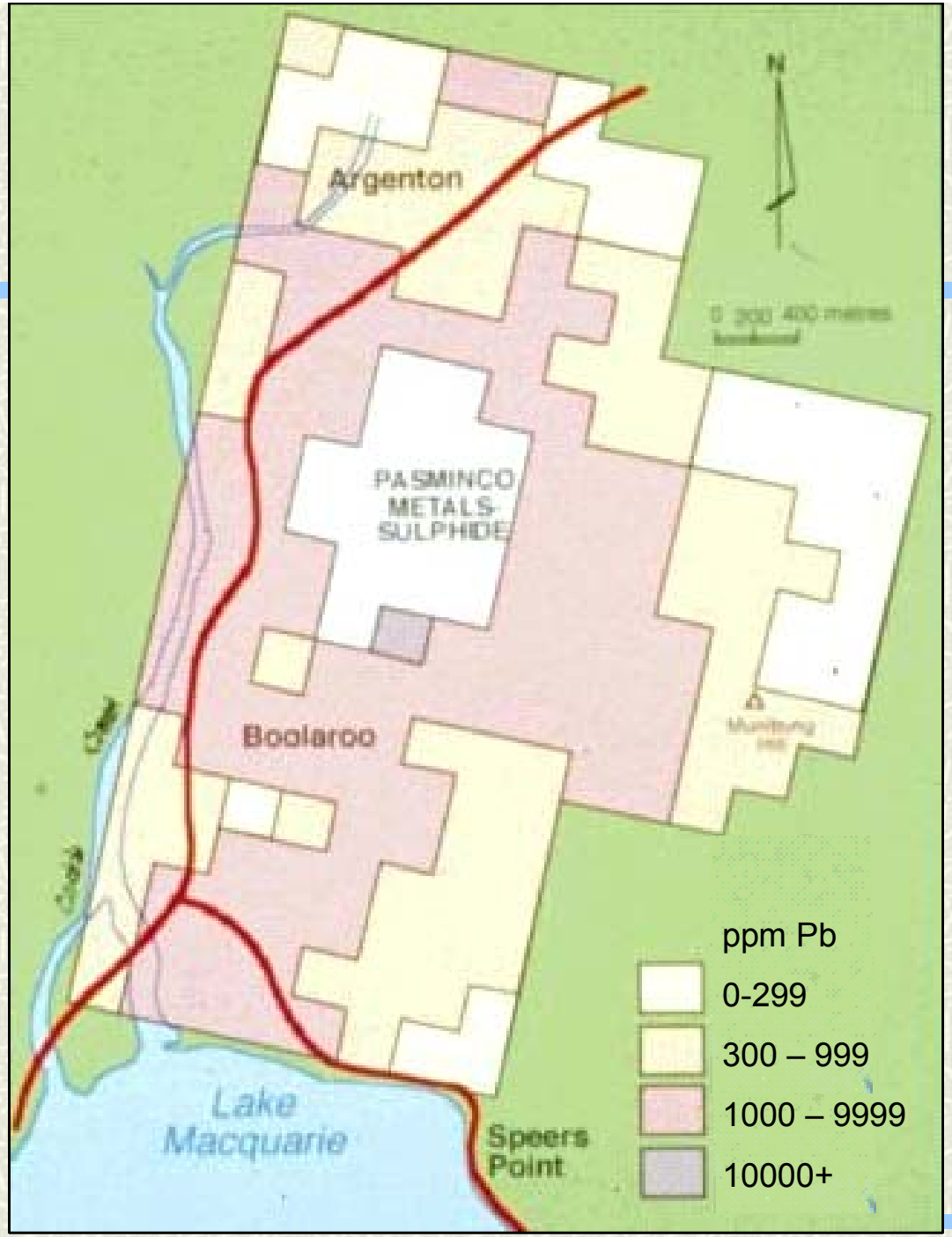
Low levels

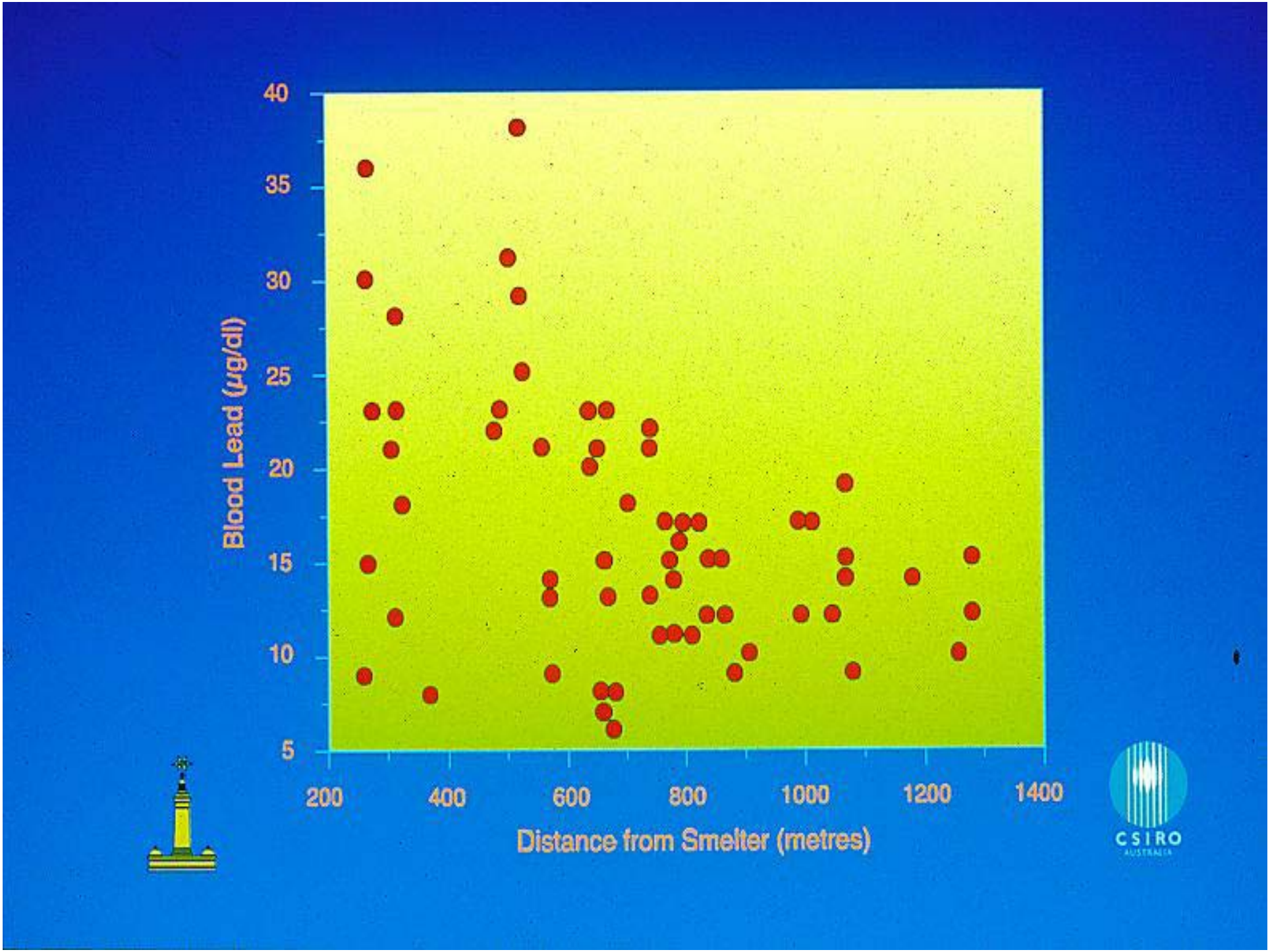
- headache, sleep disturbance, dizziness, hearing impairment, short-term memory loss

Hazard Identification for Pb - 2

Low level exposure in children

- Neuropsychological dysfunction
- Lower IQ
- Altered behaviour
- Attention deficit disorder
- Delinquency


N
Argenton
PASMINCO
METALS
SULPHIDE
Boolaroo
Lake
Macquarie
Speers
Point
ppm Pb
0-299
300 – 999
1000 – 9999
10000+


Blood Lead (µg/dl)
40
35
30
25
20
15
10
5
200
400
600
800
1000
1200
1400
Distance from Smelter (metres)
CSIRO
AUSTRALIA

House 2- Children

- Located ~550 m downwind from the smelter boundary but outside the buffer zone.
- 8 years in house from low-Pb environment
- 3 children aged 15, 9 and 3 yrs
- PbB mother of 13 µg/dl
- Youngest girl suffered from stomach pains, loss of appetite, constipation and high temperatures, respiratory problems and lost the use of her legs
- Bone scan showed possible Pb lines and a follow-up blood test was 34 µg/dl

House 2 - Environmental

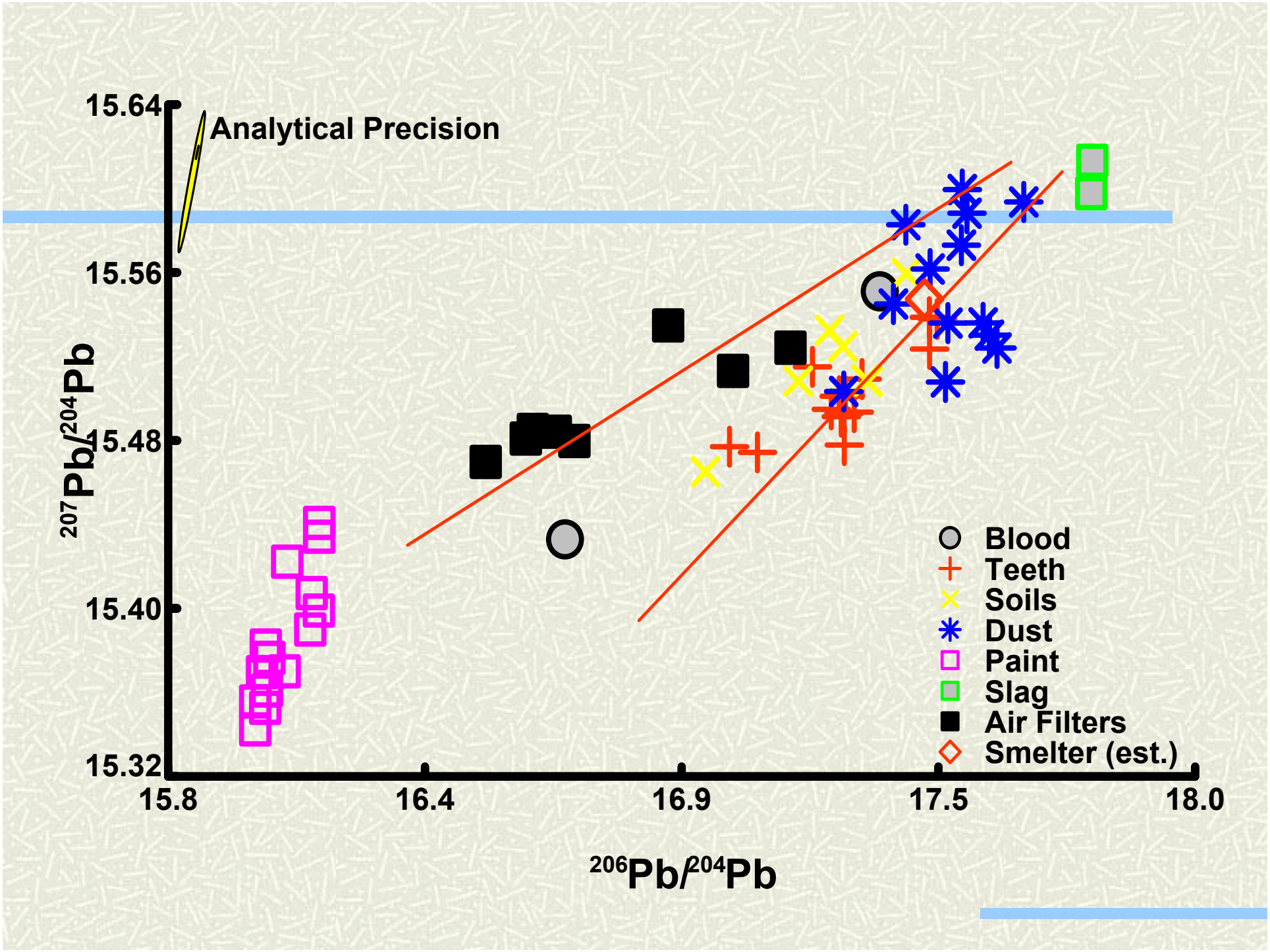
- Front yard soil 2,650 ppm Pb, backyard soil 1,010 ppm, ceiling dust 15,800 ppm (Pb loading of 3,160,000 $\mu g/m^2$ or 3.16 g/m^2)
- Front bedroom window well where the child slept had a lead loading of 12,333 $\mu g/m^2$
- Paintwork in excellent condition but leaded paint in the lower (older) layers
- House was remediated

House 2 – Remediation (?)

- Repeat tests 7 mo post-remediation -- completely repainted front wall of the house (facing the smelter) had a Pb loading of 5,935 $\mu g/m^2$, compared with a pre-remediation level of 2,950 $\mu g/m^2$
- 12 mo later -- remediated ceiling cavity dust 10,240 ppm Pb (loading of 13,820 $\mu g/m^2$)

Possible sources of lead and their lead isotopic fingerprints

- Smelter – estimated from slag and feedstock
- Gasoline – from HV air filters (Sydney; same source as Boolaroo)
- Paint – from house sampling; low $^{206}Pb/^{204}Pb$
- Diet – dietary studies very low Pb; no impact on blood or tooth Pb


Analytical Precision
15.64
15.56
15.48
15.40
15.32
$^{207}Pb/^{204}Pb$
15.8
16.4
16.9
17.5
18.0
$^{206}Pb/^{204}Pb$
Blood
Teeth
Soils
Dust
Paint
Slag
Air Filters
Smelter (est.)

Results - Soils

- Large variation in $^{206}Pb/^{204}Pb$ ratio from 16.9 to 17.5
- Variation probably reflects changes in the feedstock to the smelter over time from when the feedstock had a lower $^{206}Pb/^{204}Pb$ ratio (cf Port Pirie)
- Pattern reflects the early use of dominantly Broken Hill concentrate (Body et al.1988) with a $^{206}Pb/^{204}Pb$ ratio of 16.0

Results - Dust

- Isotopic ratios in the dust accumulations lie within a relatively restricted range from 17.35 to 17.63. House 2 with 15,800 ppm Pb; $^{206}Pb/^{204}Pb$ of 17.44 same as estimated from feedstock of 17.4
- Represent the emissions from the smelter during the 1990's
- One sample from difficult roof location 16.2

Results - Teeth

- Pb concentrations in enamel, dominantly derived from the mother, can be an order of magnitude less than in dentine, latter reflecting exposure during early childhood
- E.g. in siblings from House 4, 0.55 and 0.51 ppm Pb in enamel and 5.5 and 3.4 in the dentine for male and female respectively
- Differences in lead concentrations in the dentine are consistent with the maximum blood lead concentrations of 15 µg/dl for the male and 10 µg/dl for the female

Results - Blood

- Only two blood samples analysed
- One case, isotopic results are the same as those in a sample of soil from the front yard (in which slag grains were present), but lower than the current smelter products, evidenced in the wipes and petri dust. Estimated that >90% blood Pb was derived from current smelter activities
- In the other case, where Pb paint flakes were common in the soil and the child had pica for soil, ~45% of blood Pb estimated to come from paint

Sources of Pb -?Paint

- Use of Pb concentrations alone would not have provided answers to sources given the patterns of lead paint in the houses, former use of lead in gasoline, and the dominant presence of the smelter
- Isotopic measurements demonstrate the contribution of Pb from paint to tooth and blood is minor, except for one child

Sources of Pb - ?Gasoline

- Contribution to body burden from gasoline lead is small because of: the decreasing use of leaded gasoline, the relatively low traffic density in this area, location of the houses relative to any moderately heavy trafficked thoroughfare, and the difference in slope of the data for the high-volume air filters representing gasoline lead

Sources of Pb - ?What's Left?

- ~ 55 to 100 % of Pb in teeth could come from the smelter
- >90% blood Pb in 1 child was derived from current smelter activities
- In the other case, ~45% of blood Pb came from paint