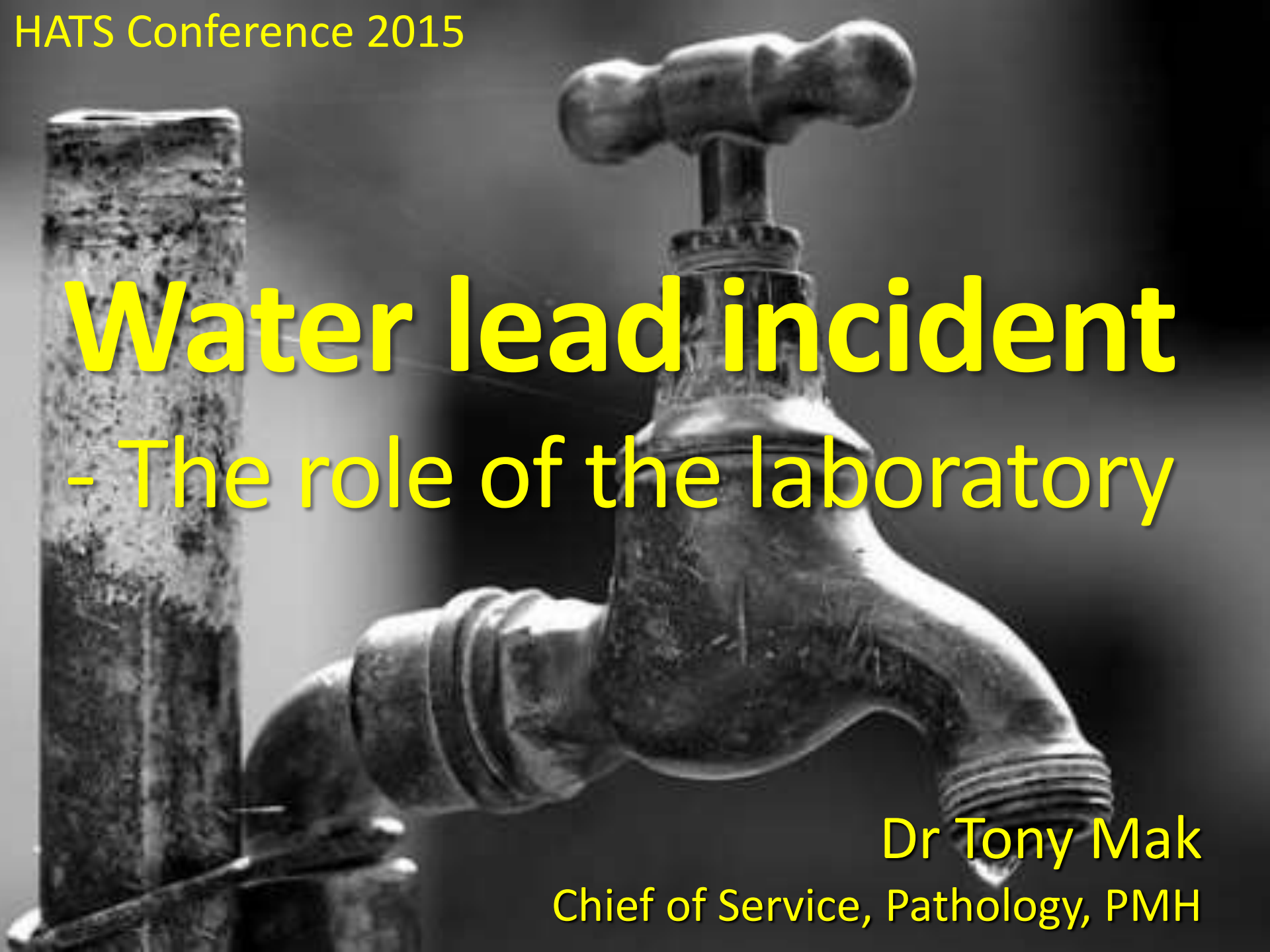
HATS Conference 2015



Water lead incident

- The role of the laboratory

Dr Tony Mak

Chief of Service, Pathology, PMH

Lead is everywhere

Battery

Fishing

Bullets

Fuel

Lead at work

Radiator repair

Welding pipes

Lead in cultural medicine

毒中鉛人婦 草夏蟲冬陸大服

9/12 30

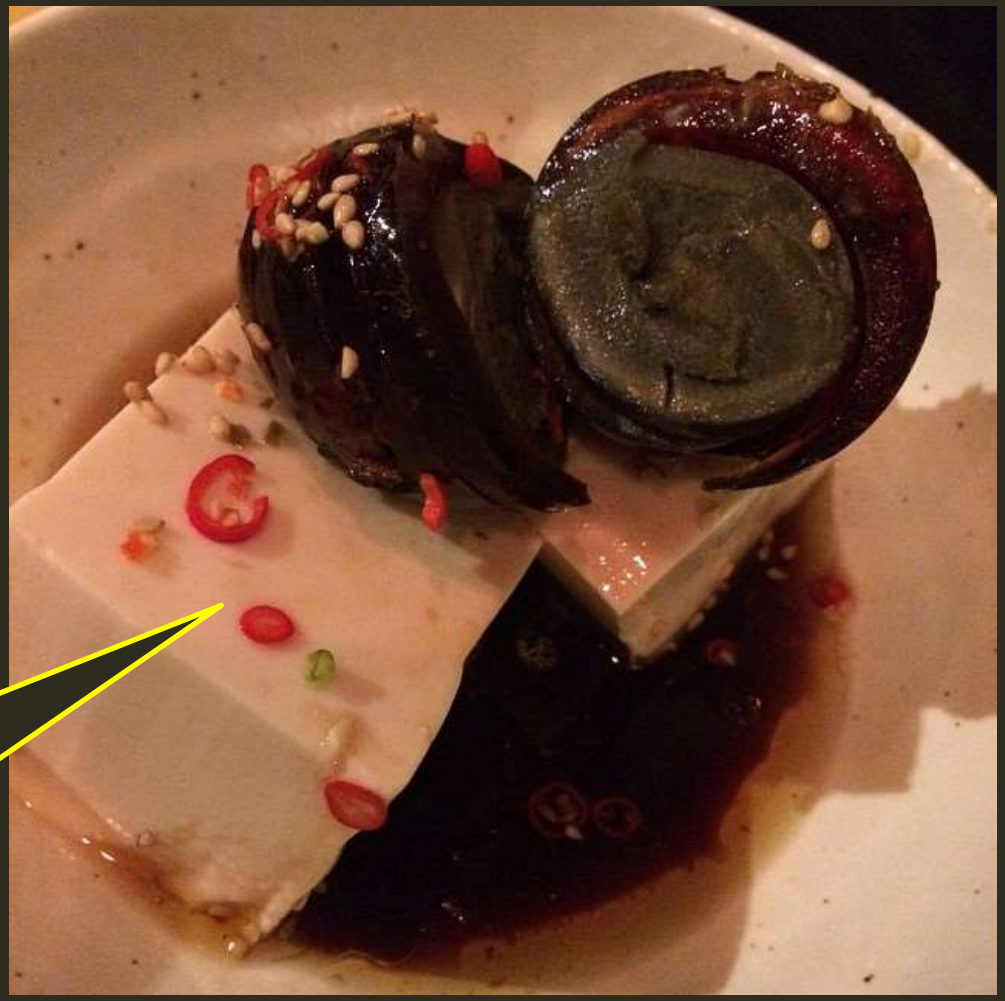
澳洲買回藥材 吃「補」變成吃「苦」

【記者梁靜于／高雄報導】高雄市一名四十五歲的龔姓婦人到澳洲旅遊，購買大陸生產的冬蟲夏草，回國後磨成粉，服用兩周後，出現疲倦、惡心等症狀，到高雄市立小港醫院門診，發現血液中含鉛量是正常人的八倍多，再化驗冬蟲夏草，果然其中含有鉛。小港醫院職業病科主任余明隆表示，幸好及時發現，中毒不深，否則後果不堪設想。

龔姓婦人兩個月前與友人到澳洲旅遊，當地導遊帶她們到一家專賣大陸中藥材的商店參觀，業者一再鼓吹銷售的冬蟲夏草品質純正，她在台灣也聽說冬蟲夏草有養顏美容、補腎、調理生理、增強免疫力，促進新陳代謝作用，花了三萬多元買了一盒。

回到高雄後，龔姓婦人將冬蟲夏草當成寶，

Lead in your food

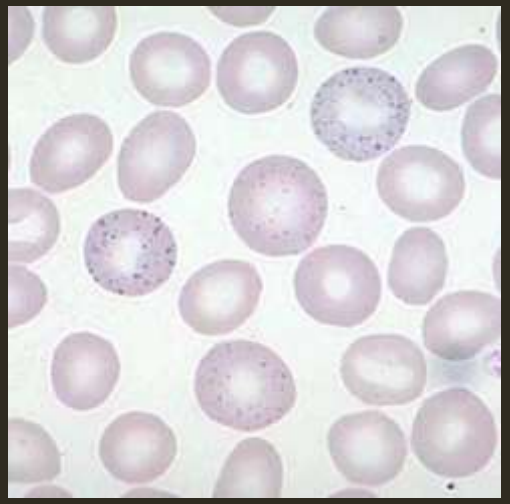


This prevents lead absorption

Lead poisoning

Clinical

Radiological

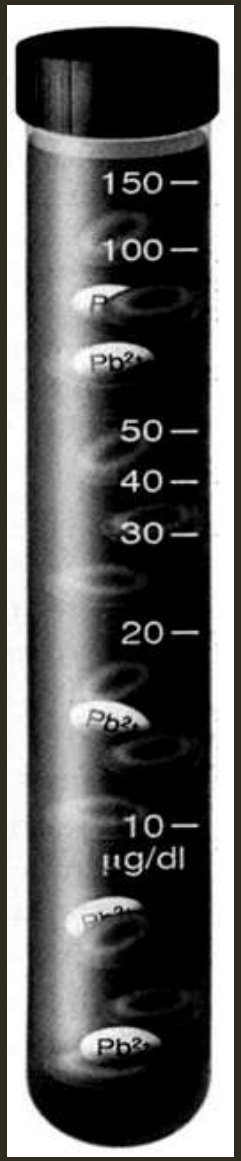


Microscopic

… and of course biochemical

BLL & Health Effects

Blood Lead Level



Death

Kidney diseases
Anaemia
Colic

Hb synthesis decreased

Impaired nerve conduction

Altered Vitamin D metabolism

Developmental problem
- **Poorer IQ**
- **Poorer hearing**
- **Poorer growth**

Biochemical changes

The best

- Blood lead level

Not useful/Potentially misleading

- Urine lead
- Hair lead
- …

The role of the laboratory

- **Question:** Lead Poisoning?
  Lead Exposure?
  Normal?

- **Answer:** Blood lead level (BLL) measurement

  - Normal → Normal
  - Slightly High → Exposure
  - Very High → Poisoning

  - Very simple!

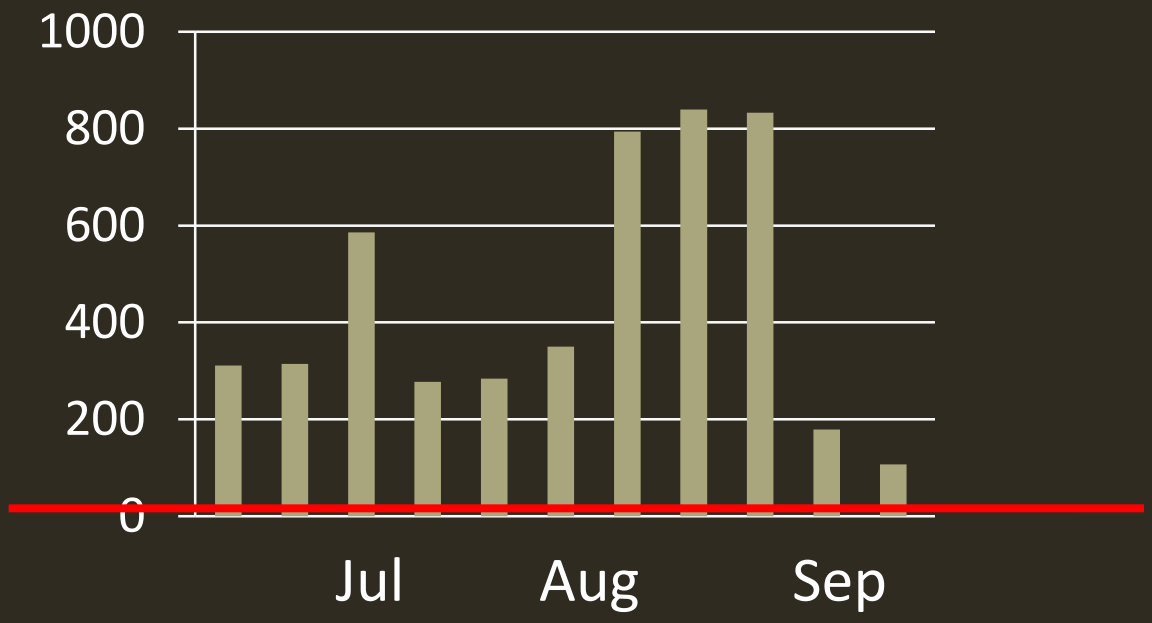
The first challenge: workload

- Blood lead level (BLL) measurement

- How many?
  - A lot!
  - But, uncertain!
  - Changed on a weekly basis!

- Historical: a handful a week
- First week: 300!

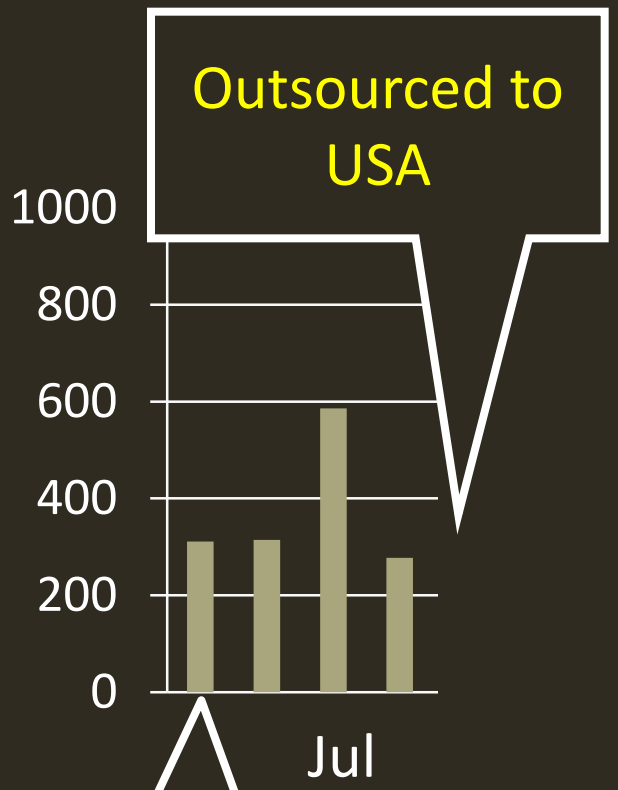
Weekly workload = 100 folds of usual



Historical weekly demand

- Demand > 100 folds of the usual demand
- Have done 20 years workload in 3 months!

The first challenge: workload



Outsourced to USA

Mobilised all HA laboratories

POCT

Designated Clinic

The first challenge: workload

- Just measure them all?

- Stock of tubes
- People running the clinic
- Space for the clinic

- Rota around the territory

- Designated clinic





The second challenge: source of lead?

- First big batch of residents (>300 cases)
- 13% abnormal!

→ It is a real problem

- What is the source of lead?

HKEJ: 4 Nov 2015

鉛水恐慌

40婦孺血鉛超標「中招」率達13%

涉27名6歲以下童 13哺乳媽媽

公屋食水含鉛，對居民構成健康影響終於有初步答案，港府昨公布第二批302名居民驗血結果，有40人中招，比例達13%。

被驗出血鉛水平超世衛標準，即每100毫升血含5微克或以上鉛，27人為6歲以下小童，最嚴重個案為一名小於1歲的嬰兒，血鉛達14.2微克；另亦有13名哺乳媽媽中招。

■本報記者 楊玉珠

血鉛檢測結果

驗血人數	302
血鉛水平偏高	共40人，包括27名6歲以下兒童及13名哺乳婦女
血鉛水平範圍	每100毫升血含鉛5至15微克
血鉛偏高所佔比例	13%
血鉛偏高者	39人住啓晴邨、1

血鉛超標知多些

問：6歲以下小童、孕婦、餵哺母乳媽媽，血鉛量多少會影響健康？

答：據世衛和美國疾控中心標準，如3類人士每100毫升含5微克鉛，便有機會構成風險，一般人為10微克

問：上述3類人士的血鉛水平為何容易較高？

答：與飲食習慣及身體結構有關，幼童食物主要為奶類流質食品，哺乳婦女需生產乳汁而多飲湯水；小童腸道結構和成人不同，食用含同一水平鉛的食水時成人僅吸收到1%鉛，3歲以下小童吸收的分量卻可30至40%鉛。

問：血鉛水平超標怎辦？

The second challenge: source of lead?

- Results of this batch:

	Number	BLL High	
Children	230	27	11.7%
Pregnant	21	0	0%
Lactating	41	13	31.7%
Others	10	0	0%
Total	302	40	13.2%

- Younger children: more commonly affected
- Lactating women: more commonly affected

→ Water is the source of lead?

The second challenge: source of lead?

Lead Isotope Pattern Analysis

Concept

- Naturally occurring isotopes of lead:

Isotop	Relative Proportion (approx.)
Pb 206	25%
Pb 207	25%
Pb 208	50%

- Relative proportion of the isotopes (the “isotope pattern”):

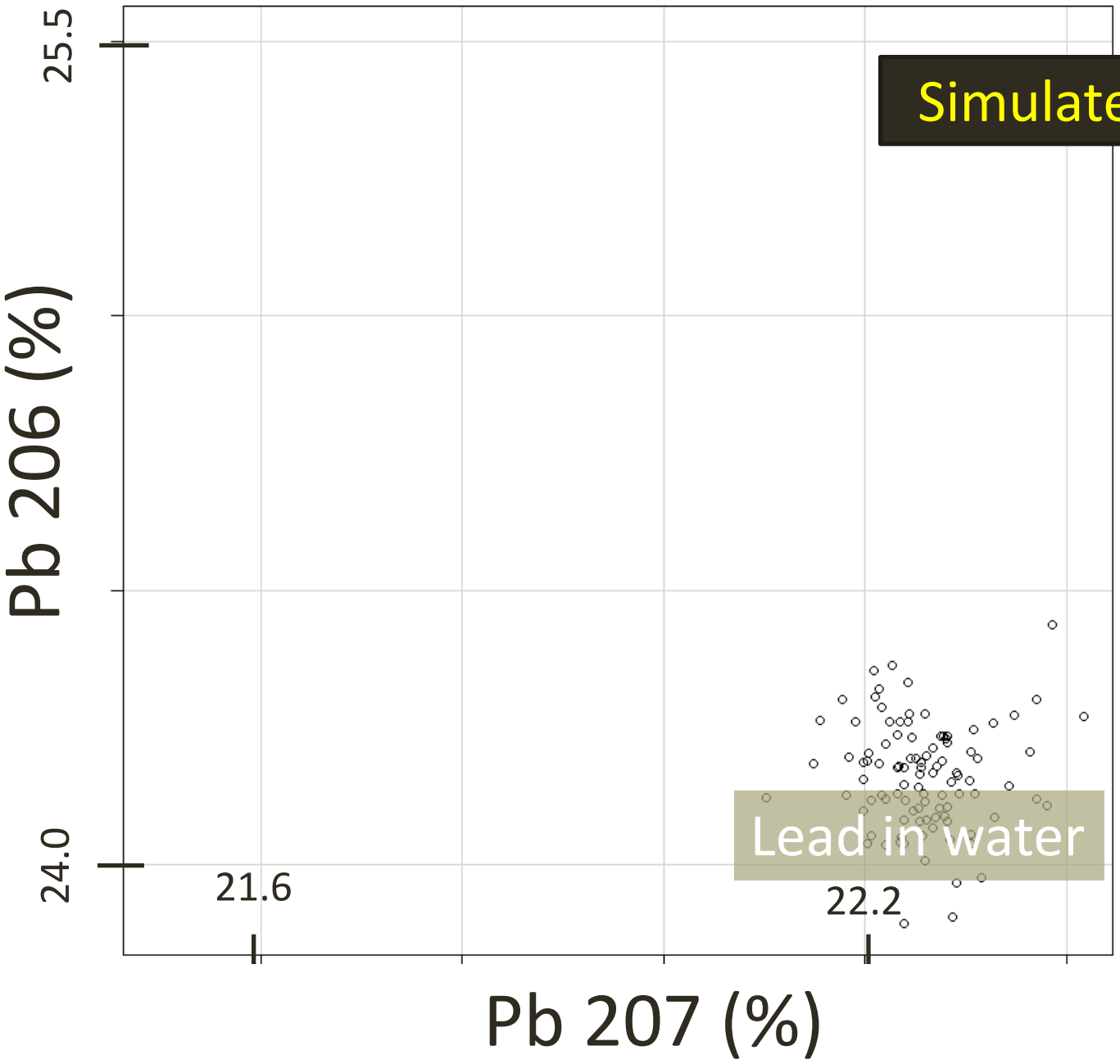
→ slightly different for different sources

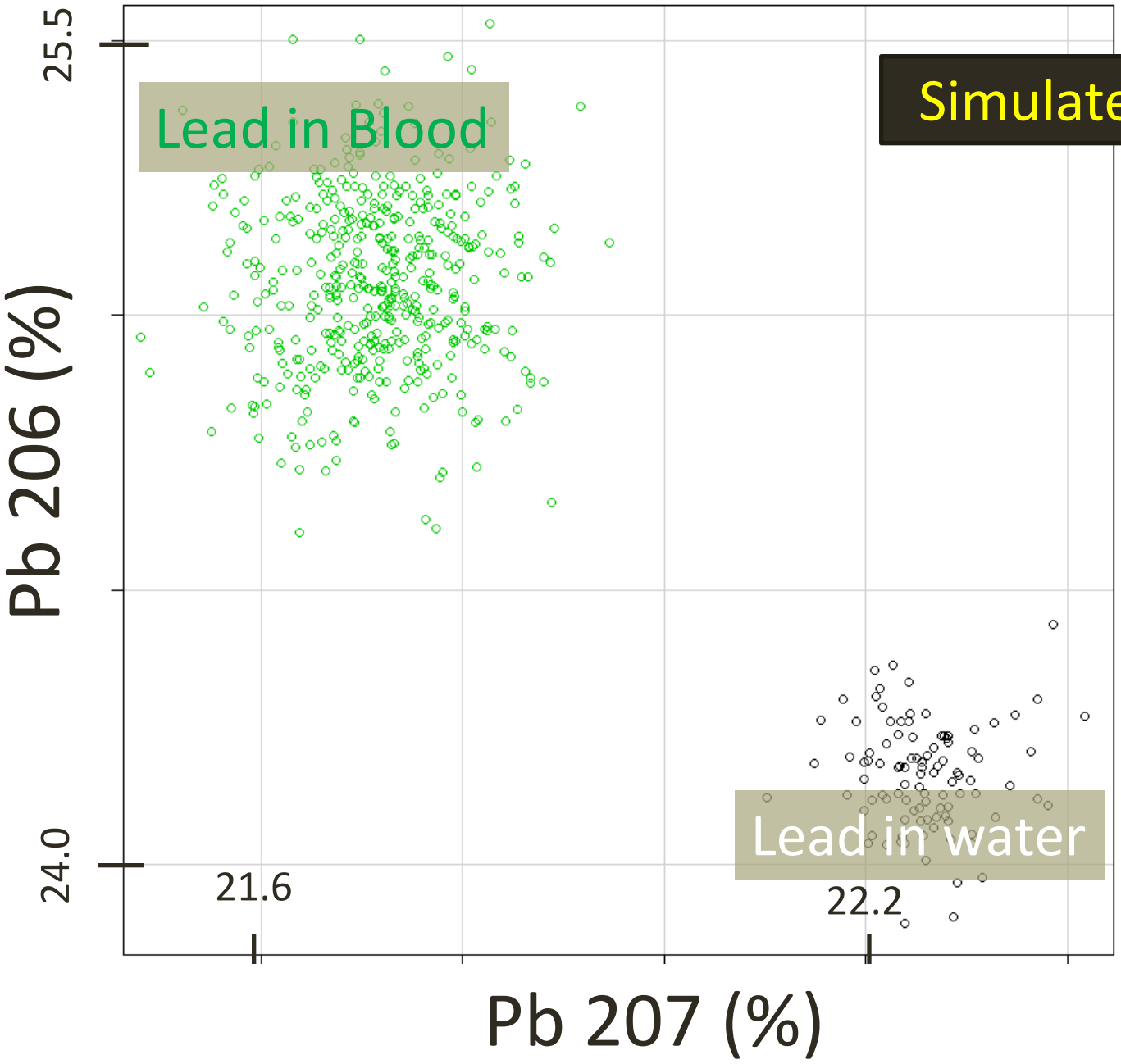
- Blood lead isotope pattern is a “summation” of all sources

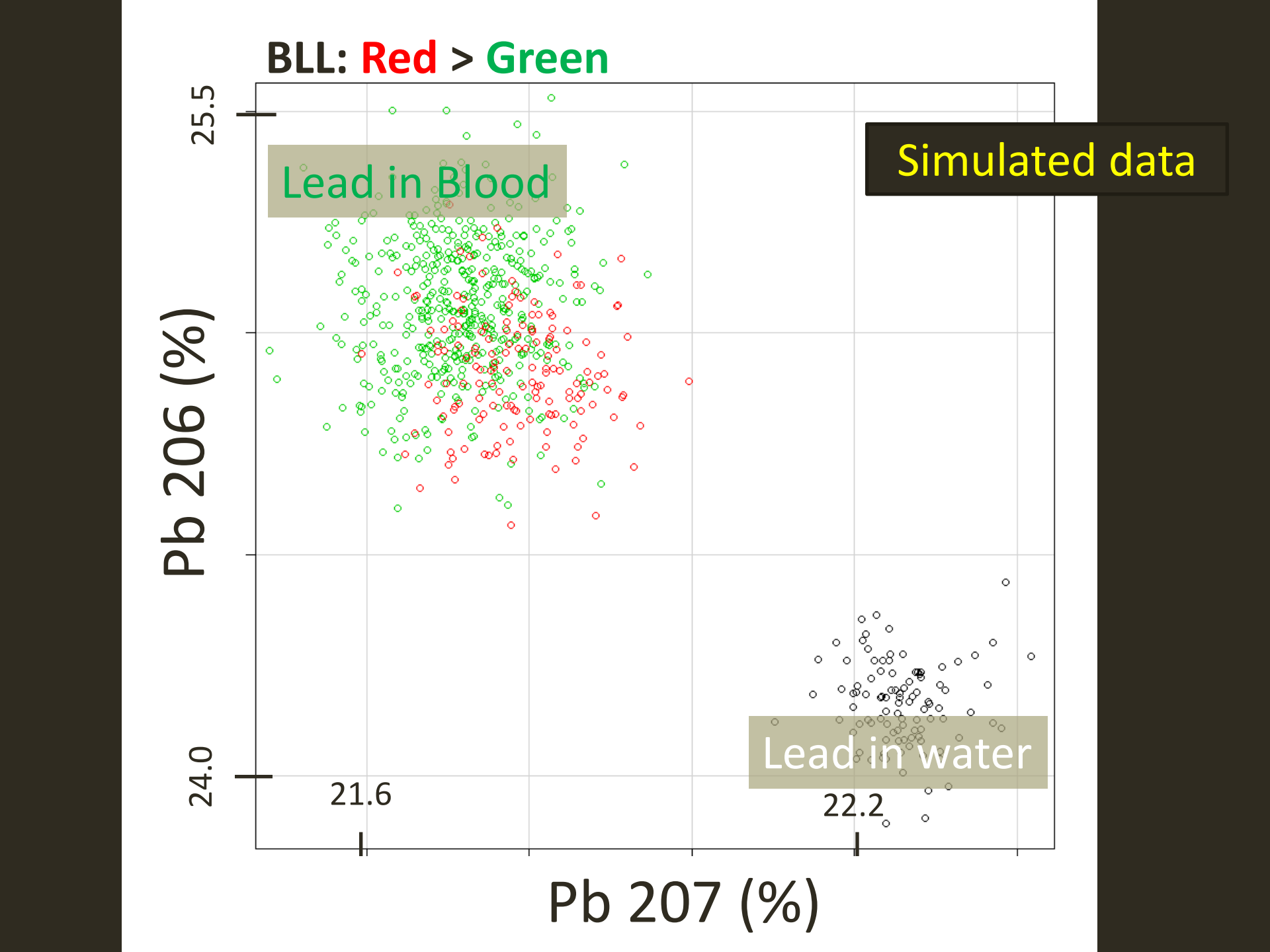
Concept

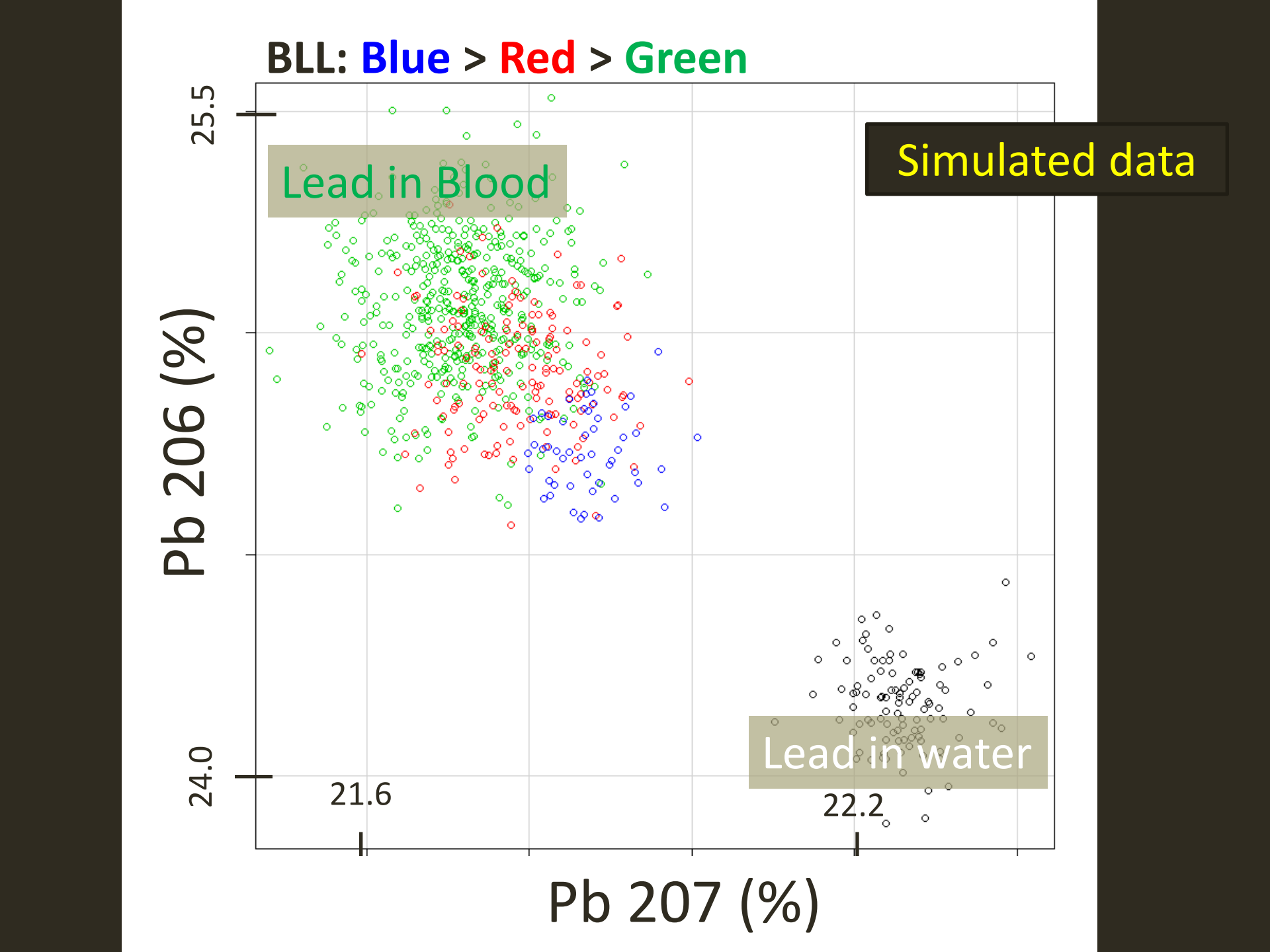
- Comparing the isotope patterns of a particular source with that in blood

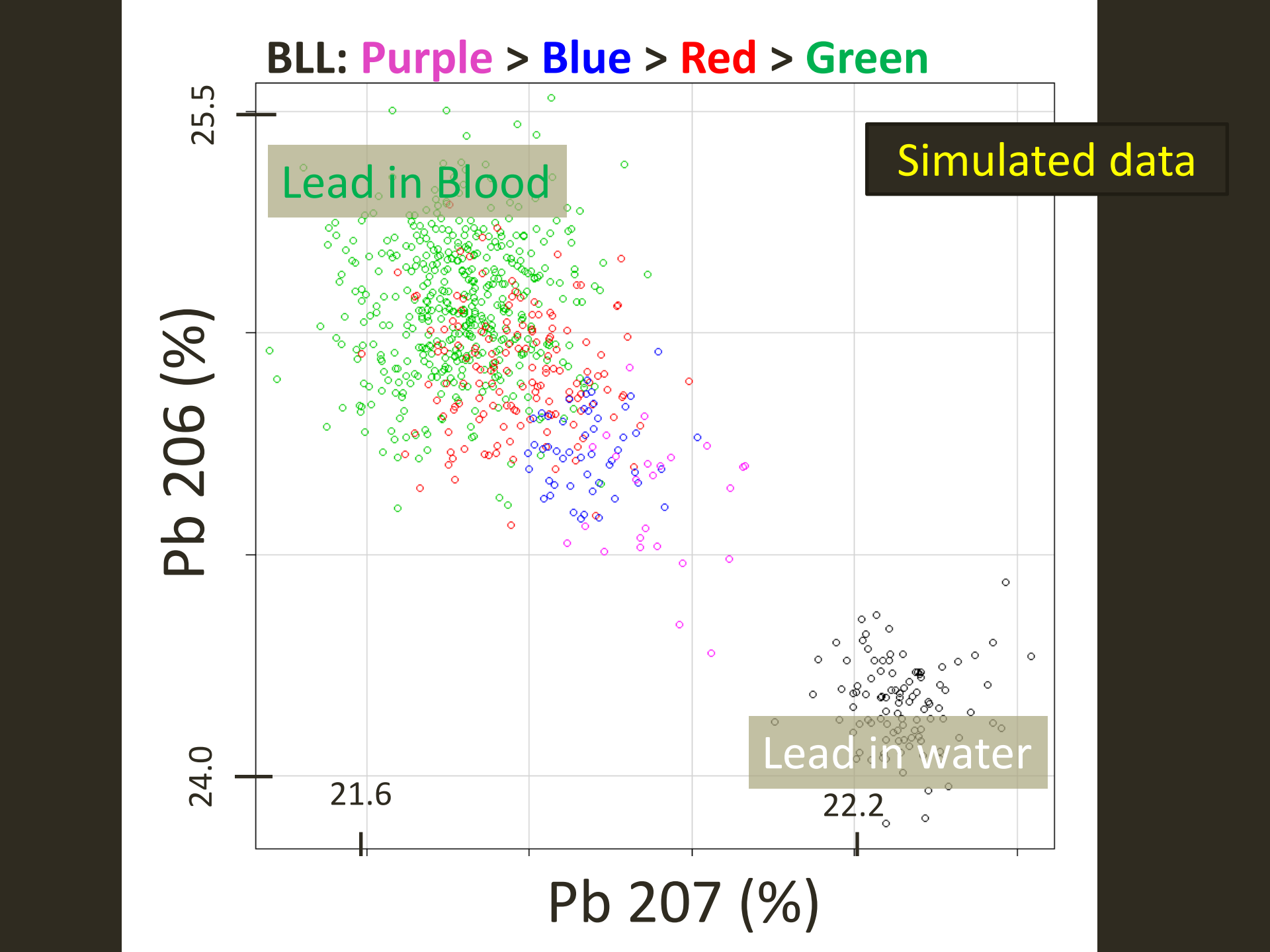
→ may be informative


Simulated data
Lead in water
Pb 206 (%)
25.5
24.0
21.6
22.2
Pb 207 (%)

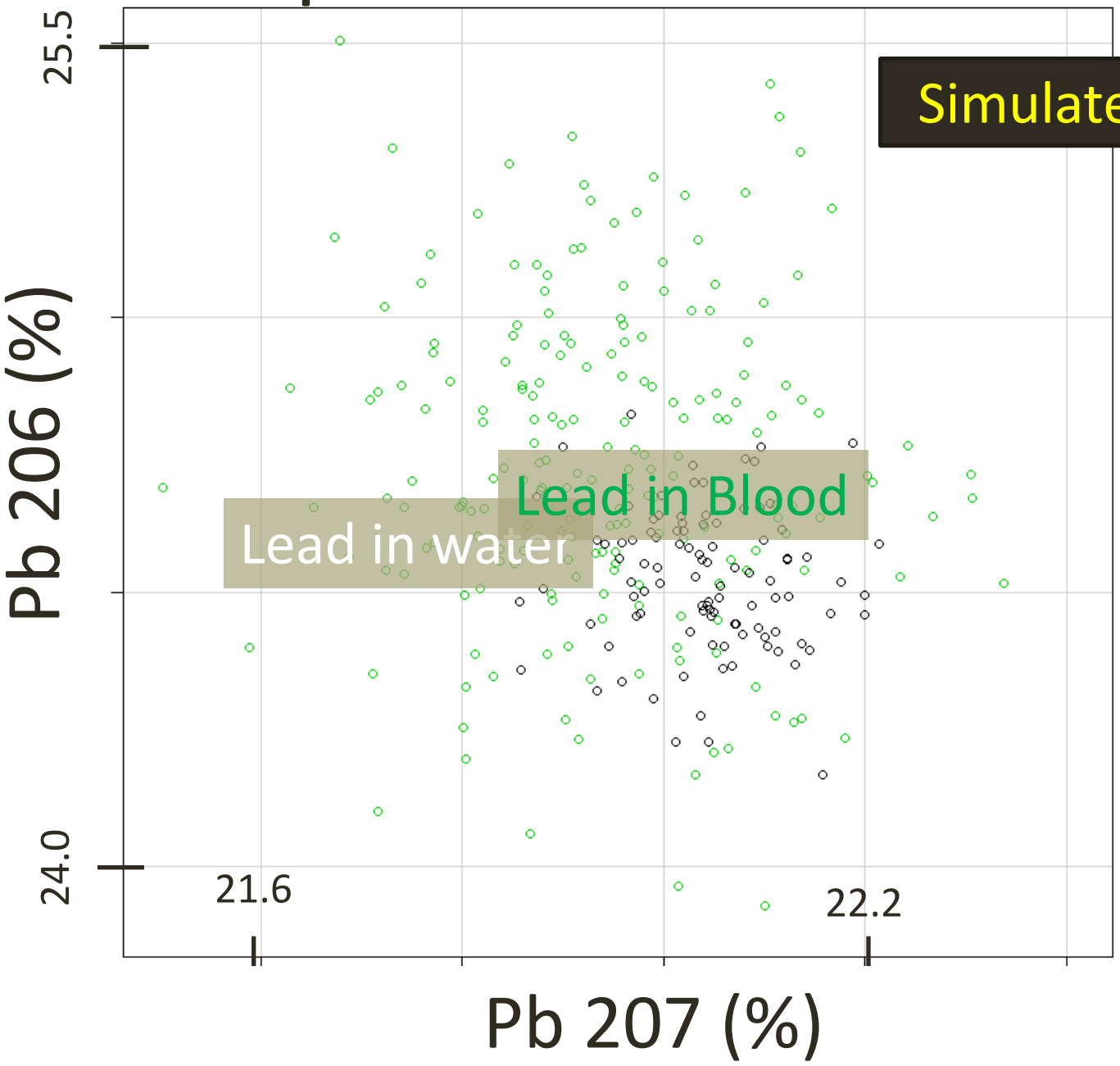

Simulated data
Lead in Blood
Lead in water
Pb 206 (%)
25.5
24.0
21.6
22.2
Pb 207 (%)


BLL: Red > Green
Simulated data
Lead in Blood
Lead in water
Pb 206 (%)
Pb 207 (%)
25.5
24.0
21.6
22.2

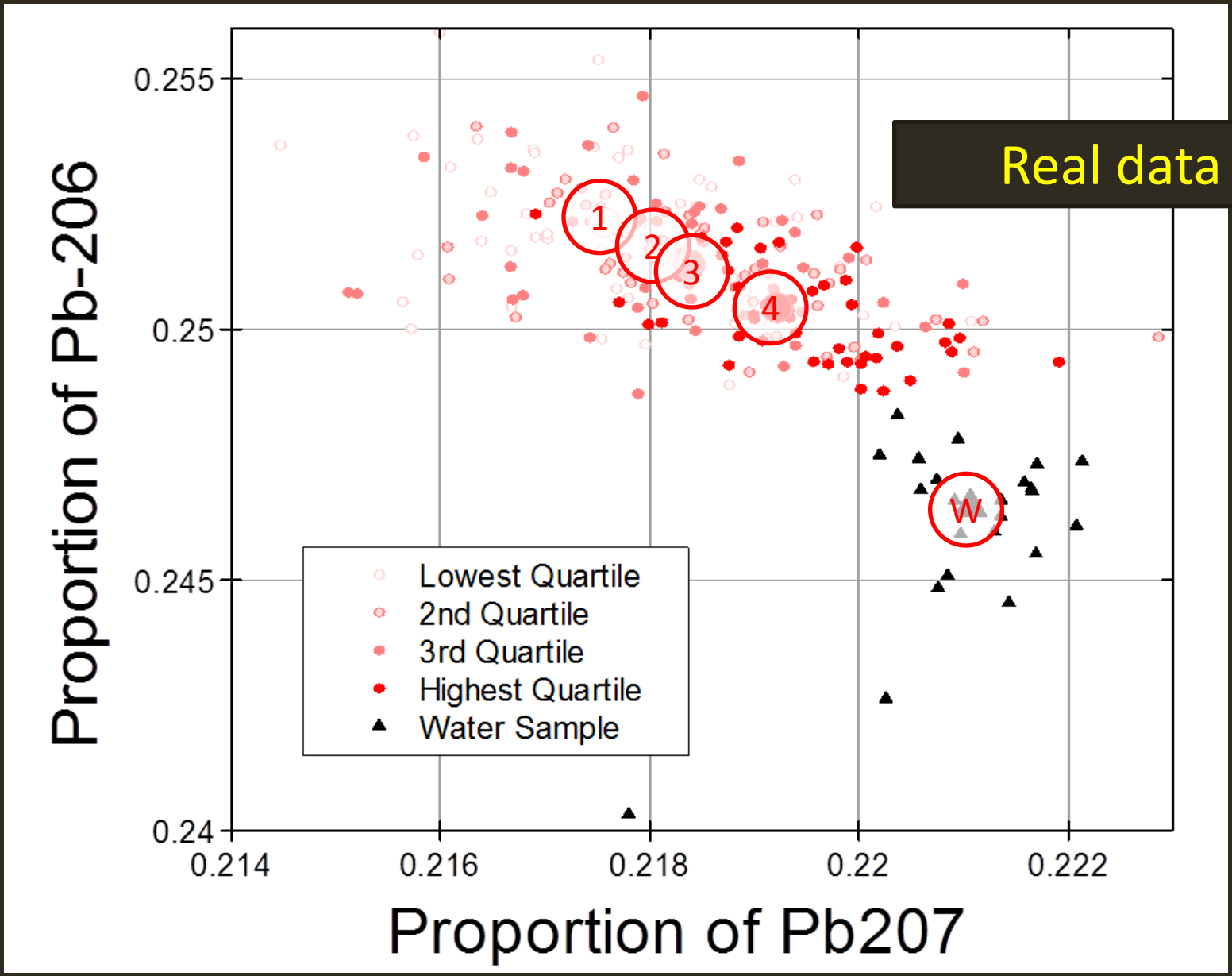

BLL: Blue > Red > Green
Simulated data
Lead in Blood
Lead in water
Pb 206 (%)
Pb 207 (%)
25.5
24.0
21.6
22.2


BLL: Purple > Blue > Red > Green
Simulated data
Lead in Blood
Lead in water
Pb 206 (%)
Pb 207 (%)
25.5
24.0
21.6
22.2

These patterns are NOT informative



… and here comes the real data!



Lead in blood is from lead in water!

比對同位素分布 高永文科學辦證

居民血含鉛食水攸關

鉛水恐慌

政府日前為23名血鉛超標的兒童進行智力測試，發現當中三名兒童智力發展遲緩。食物及衞生局局長高永文昨日指出，目前未有劃一標準顯示個案是否與含鉛量高的食水有關，局方將繼續跟進個案，若發現智力偏差較少，不排除長大後可追回偏差，但要待兒童上小學或幼稚園時才能確定腦部受影響情況及其嚴重性。另外，他透露專家正比對血鉛與水辦中的鉛，同位素分布是否一致，初步看到兩者數據接近，反映科學角度上，居民的血液含鉛很可能與食水含鉛有關。

本報港聞部報道

交綜合兒童發展評估中心跟進，其他兒童可按母嬰健康院的檢查機制，兒童出世一段時間後，母親可帶同其到母嬰健康院接受早期發展評估，若評估發現有異，會轉介綜合發展評估中心跟進，部分會轉介至公立醫院兒科跟進，但目前為兒童的檢測專才不多，若未來有更多兒童血鉛超標，會對醫療系統造成一定壓力。

Secretary of Food & Health: Isotope pattern analysis - Blood lead in residents is related to water

鉛有關。

上的刺激，多些與他們談話以及有多些活動機會等。

The source of lead in water

- Water supply department
- Source of lead in water was from solder
- The lead content of solder is 41%!
- The isotope pattern of lead in water matched that of solder!

主編推介

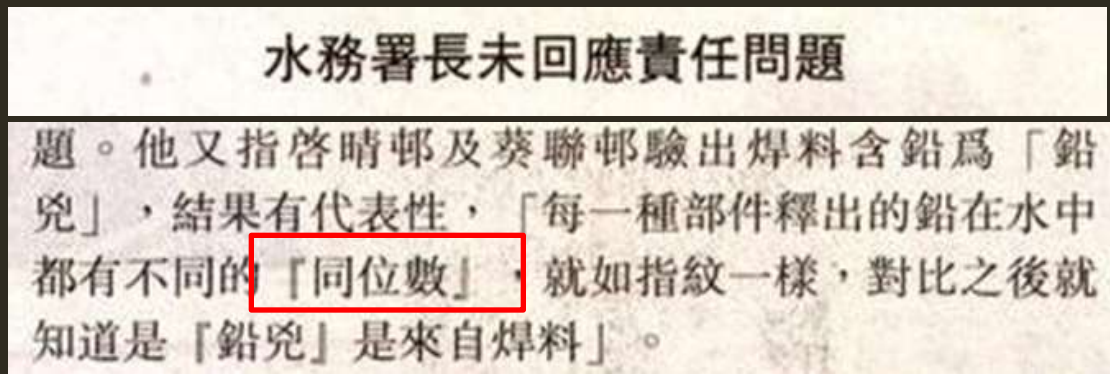
焊料滲水管壁致鉛水

專責小組報告未提責任賠償

水署認監管機制有不足

含鉛焊料滲入喉管示意圖

MingPao 26 Sep 2015

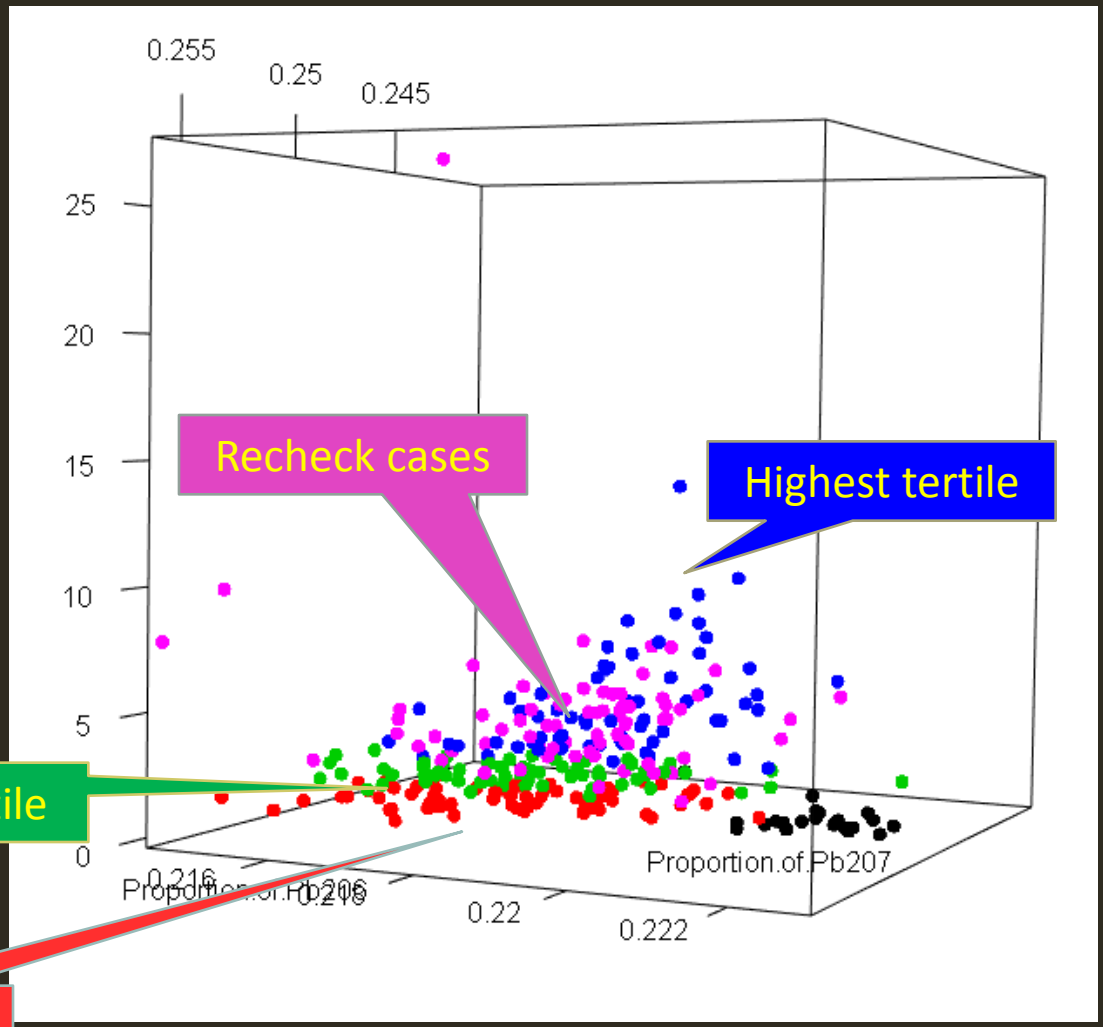


水務署長未回應責任問題

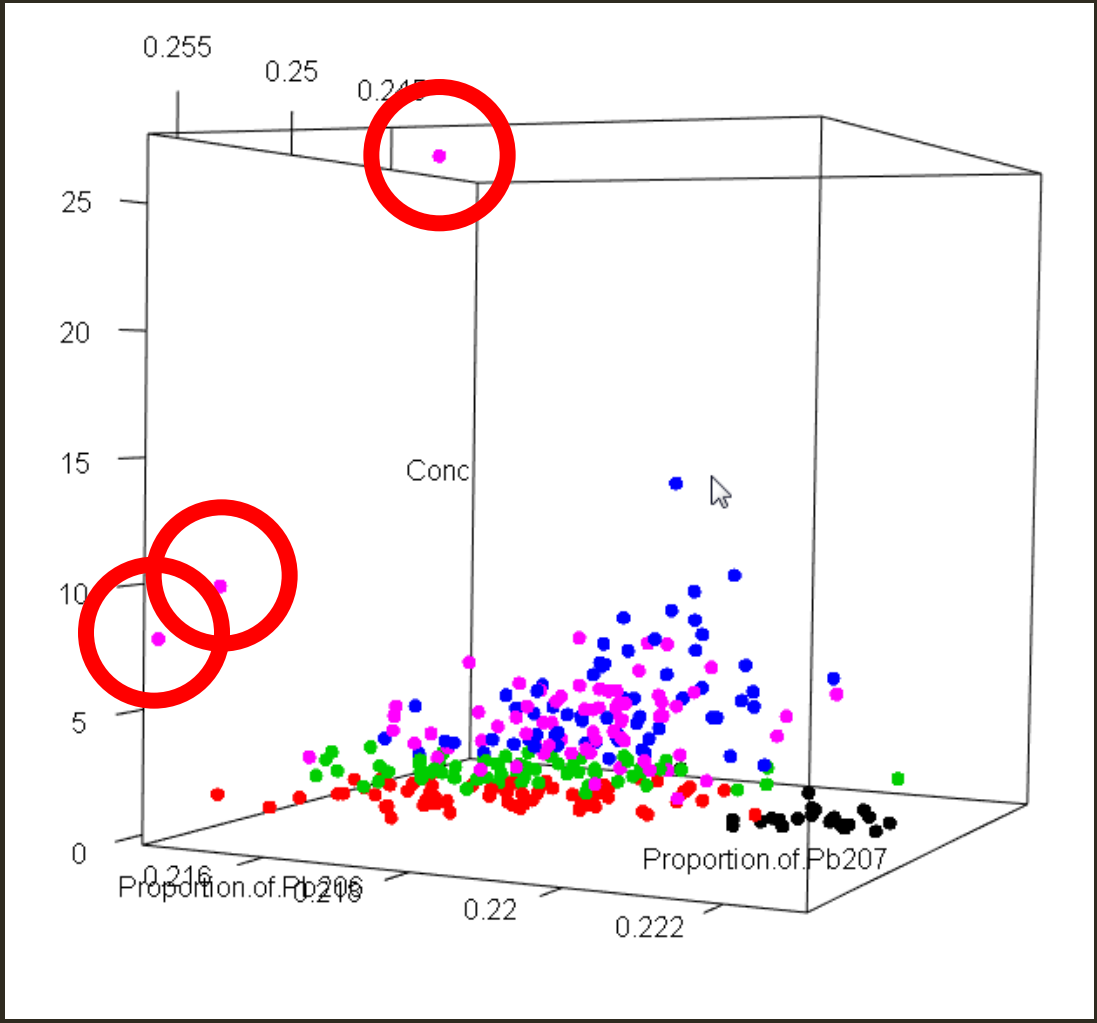
題。他又指啓晴邨及葵聯邨驗出焊料含鉛爲「鉛兇」，結果有代表性，「每一種部件釋出的鉛在水中都有不同的『同位數』，就如指紋一樣，對比之後就知道是『鉛兇』是來自焊料」。

Isotope Pattern: Finger Printing of Lead

Applying the isotope model



Applying the isotope model

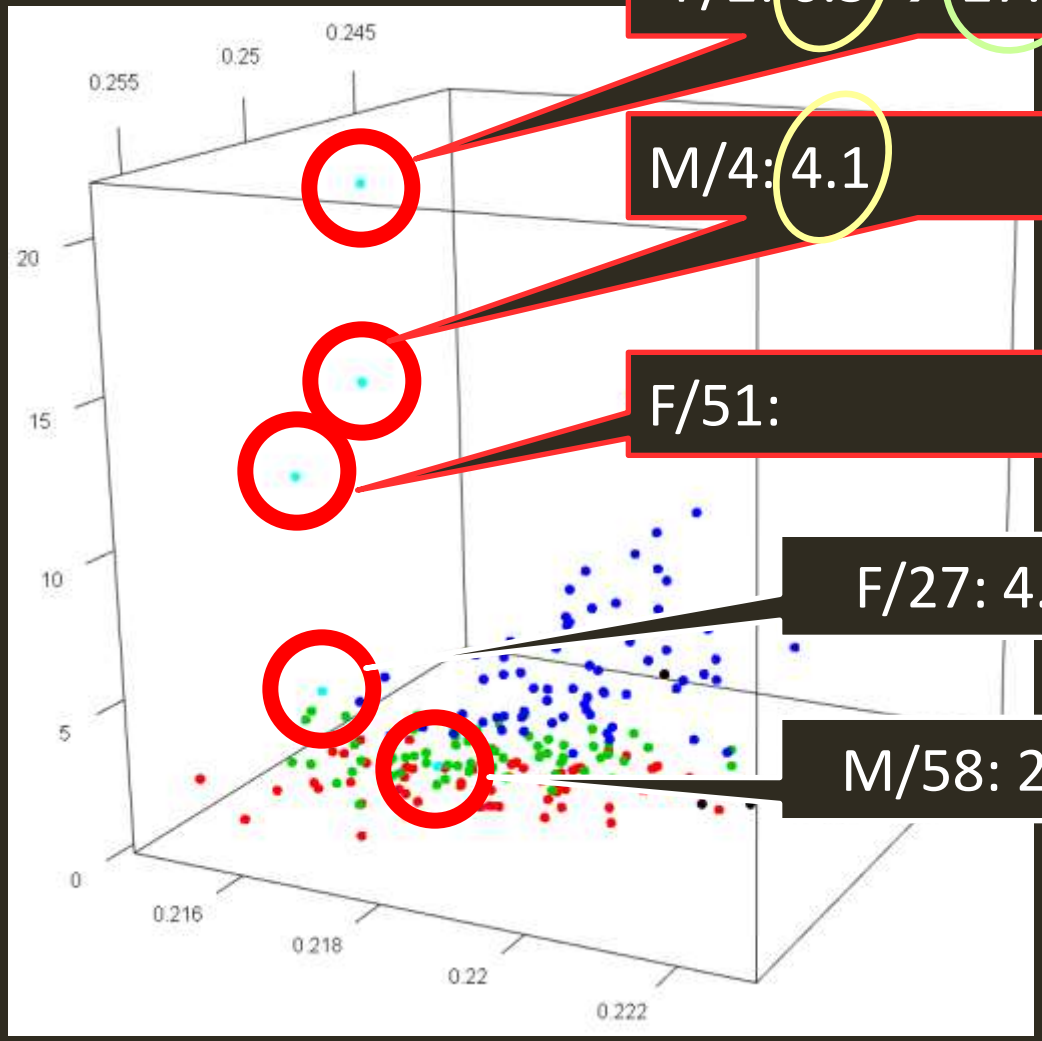


Most looked the same

However:

Outliers have a **different** source of lead!

Case 1 (a family)



F/2: 6.5 → 27.3 → 21.4 — Daughter

M/4: 4.1 → 14.7 — Son

F/51: 12.2 — Mat GM

F/27: 4.9 ug/dL — Mother

M/58: 2.9 ug/dL — Father

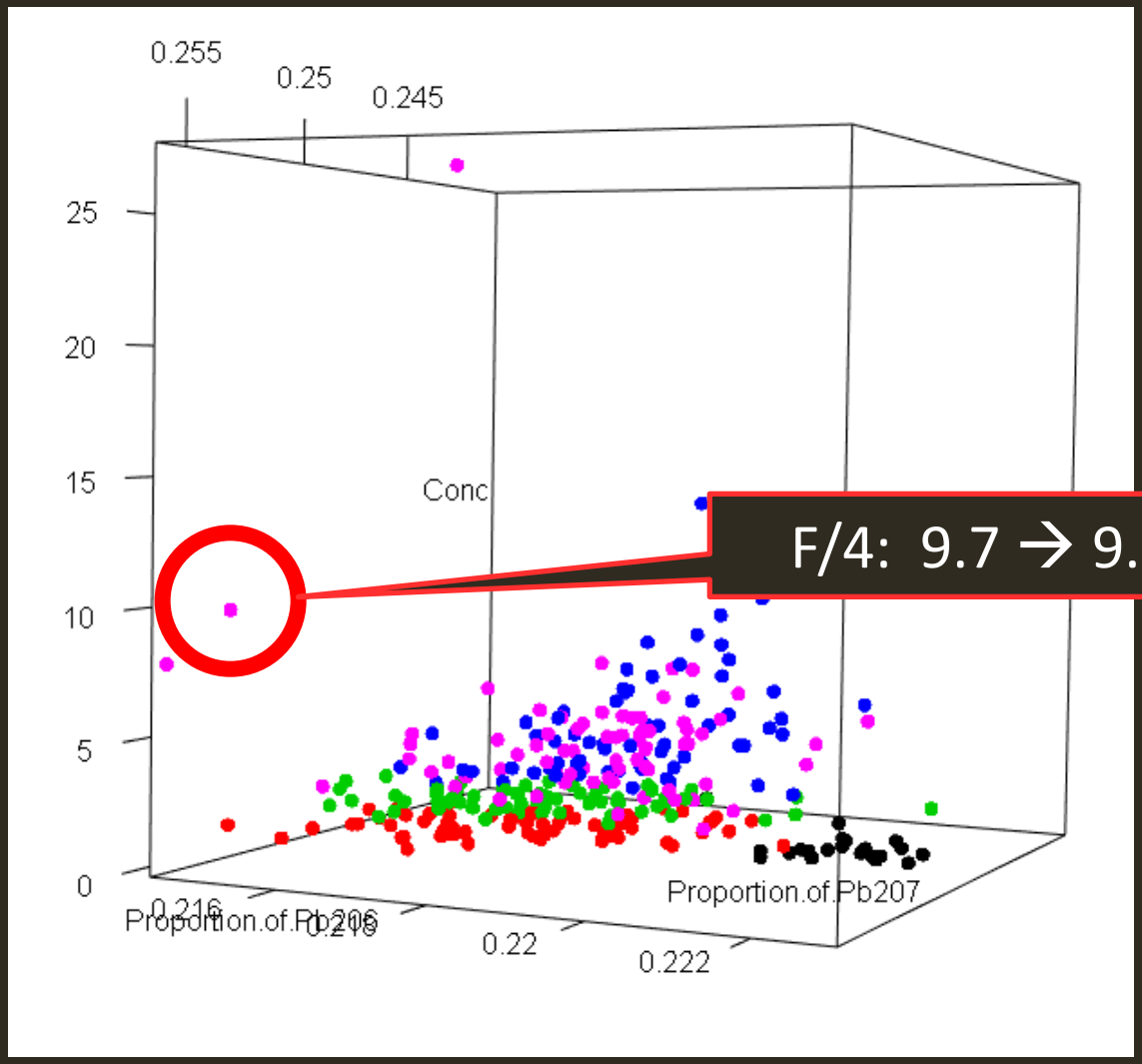
Rising BLL?

Case 1 (a family)

- Filter installed
- Exposure stopped
- Lead become higher

- **Why?**

Case 2



Rising BLL?

Case 2

- Filter installed
- Exposure stopped
- Lead become higher

- **Why?**

- Lived in an apartment elsewhere **during weekdays**

Unrelated!

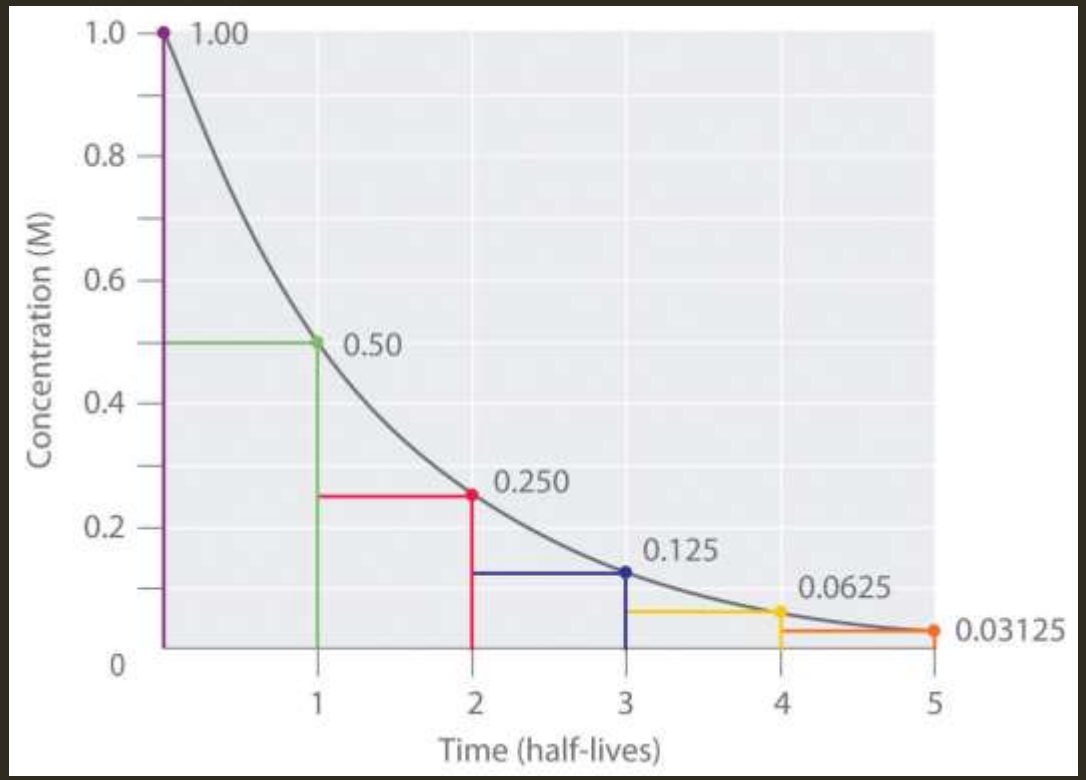
Challenge 3: When will my BLL return to normal?

- No local data

- Local toxicologists:
- The blood lead elimination half-life is 30 days!

What is half-life?

- Time required to drop to 50% of the initial value
- Drug elimination
- Radioactive substance decay



What is half-life?

- A child from Kwai Luen Estate
- BLL in July: 7.6 ug/dL
- One month later: 6.0 ug/dL
- The Government: decrease of BLL is individualized!

What is half-life?

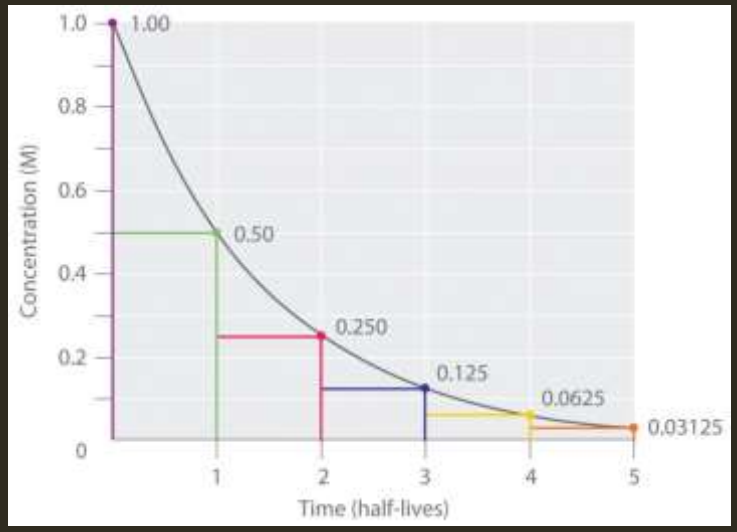
TABLE 4-3 Studies of Kinetic Behavior of Lead in Blood of Children

Study Group and Exposure	Half-Life, days	Comments (References)
Infants, middle class; ambient exposure	-	Blood lead very unstable for first 20 mo Rabinowitz et al., 1984)
Infants, middle class; ambient low exposure	5.6	Reanalysis of Ziegler et al. et al. (1978) data; mean-time 8 days (half-life, 5.6 days) (Duggan, 1983)
Infants, low socioeconomic status; heavy ambient exposure	ca. 300	Reflects high body burden plus in utero uptake in urban setting (Succop et al., 1987)
Low-socioeconomic-status children of battery workers; secondary exposure	-	Rank order of group preserved over 5 yr; $r = 0.74$ (Schroeder et al., 1985)
General U.S. child population; varied exposure	-	Regression analyses of NHANES blood lead data showed 30-day (best-fit) lag with lead source (Schwartz et al., 1985; Annest and Mahaffey, 1984)
School-age English children; low exposure	-	Two blood lead sets, 20 mo apart; rank order preserved (Landsdown et al., 1986)
U.S. children, 4–12 yr old; increased ambient exposure	-	Rank order of serial blood lead measures generally preserved (David et al., 1982)

- References:
- Half-lives ranged from 5.6 days to 300 days!

What is half-life?

Drug elimination



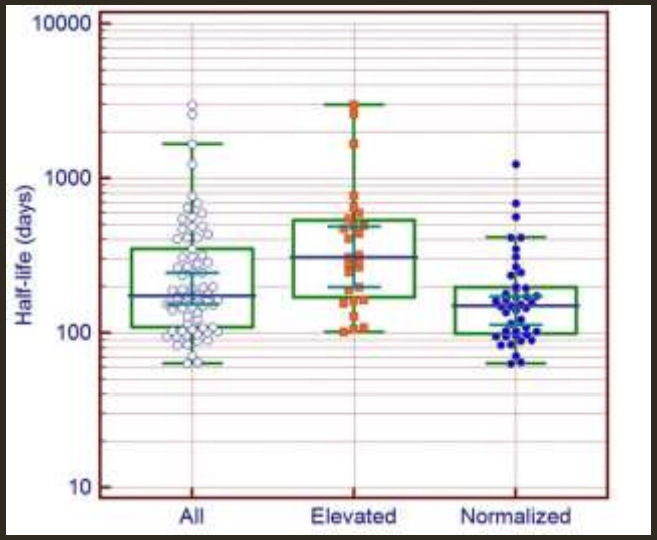
Lead:

- Continuous exposure
- Multiple sources
- Gradual release to blood from internal organs

- Half-life of BLL: 30 days
- Half-life of lead in bone: 25 years

Local lead half-life

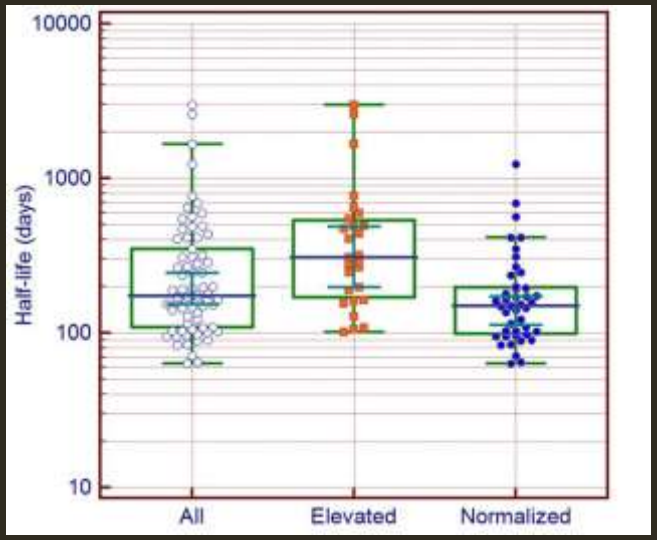
- Late October 2015
- First batch of repeats



- Overall $t_{½}$: 6 months

  - Residents whose BLL returned to normal
    $t_{½}$: 5 months
  - Residents whose BLL remained high
    $t_{½}$: 10 months

Local lead half-life

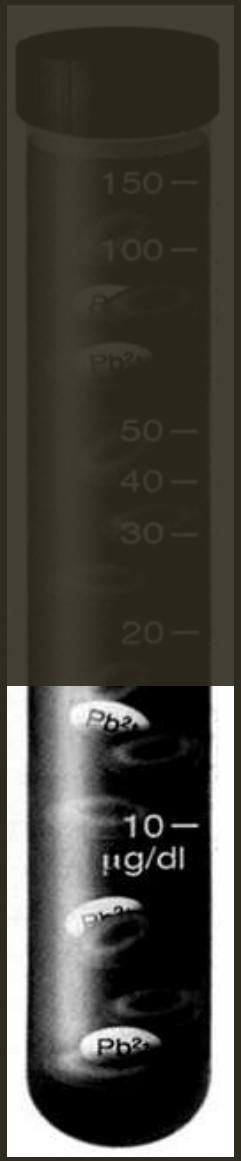


- Overall $t_{½}$: 6 months

- The elimination half-life is unexpectedly long
- A continuous source of lead?
- Where is it?
- BONE?

BLL & Health Effects

Blood Lead Level



Death

Kidney diseases
Anaemia
Colic

Hb synthesis decreased

Impaired nerve conduction

Altered Vitamin D metabolism

Developmental pro
- Poorer IQ
- Poorer hearing
- Poorer growth

10-20: 11 (0.2%)

5-10: 182(3.2%)

< 5: 5460(96.6%)

Conclusions

- Mild but definite exposure
- Water was the source
- Most worrying: developing children
- Eliminate all lead-containing pipes
  - → Water sample collection method
  - → Overnight, not after running for 10 min!

Thank You!