

# Isotope ratio measurements using ICP-MS/MS for source attribution of priority pollutants in air

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# National Physical Laboratory

The UK's National Measurement Institute, engaging with government and industry

Founded in 1900

Responsible for establishing, maintaining and disseminating national standards and measurement science

~900 employees and ~150 students with Postgraduate Institute

Purpose built laboratory campus in Teddington, UK

Operated and owned by the Department for Business, Energy and Industrial Strategy (BEIS)



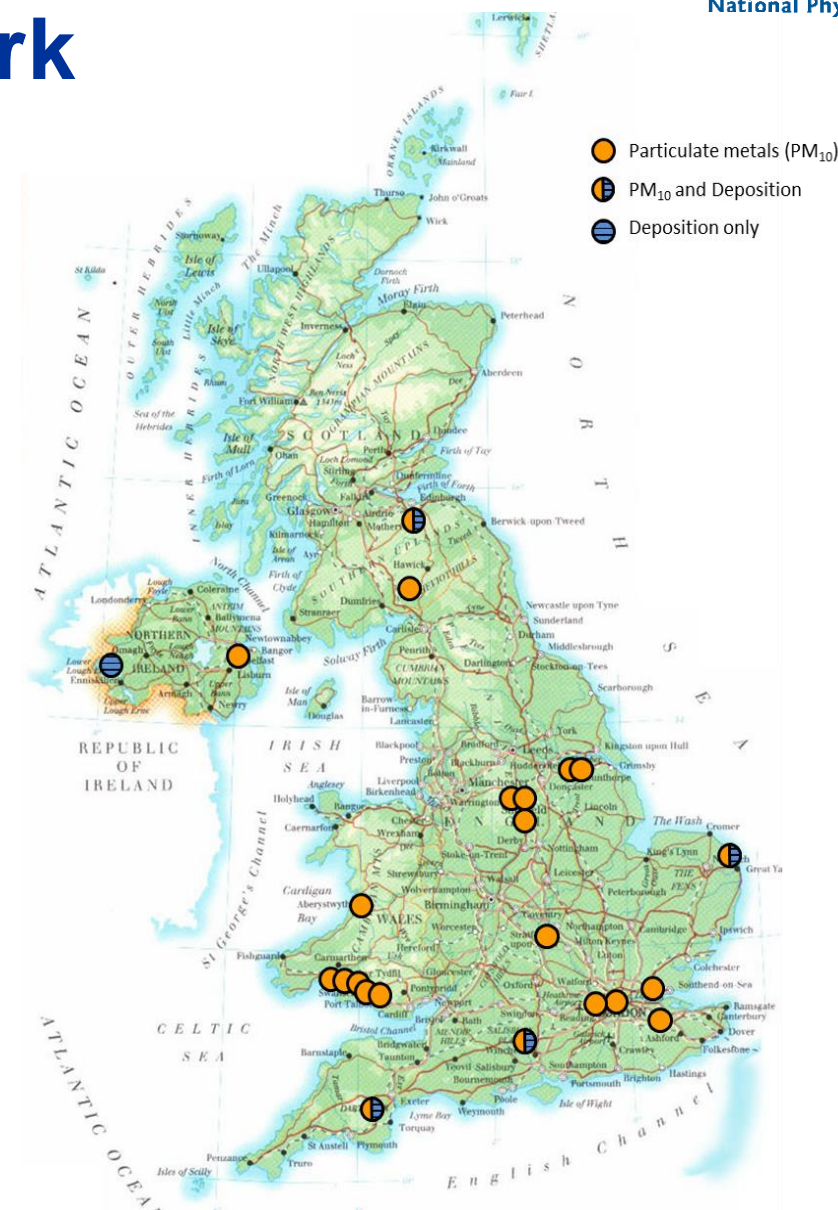
# Air Quality and Aerosol Metrology: UK Heavy Metals Monitoring Network

NPL runs the UK Heavy Metals Monitoring Network for the EA and DEFRA to ensure UK compliance with legislation

24 monitoring sites across the UK

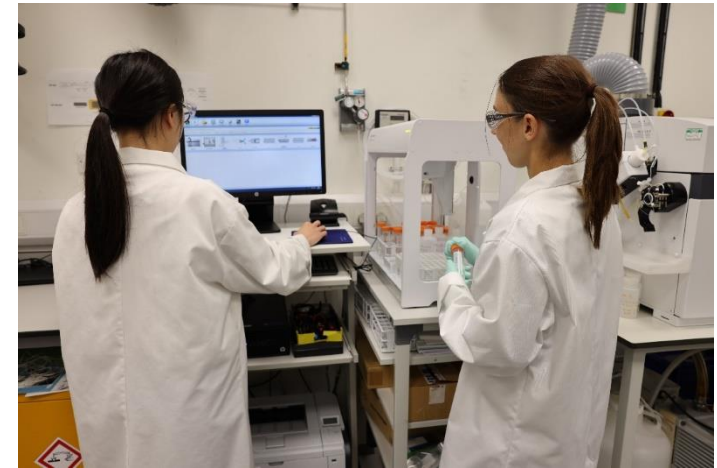
Particulate Matter of  $10\text{ }\mu\text{m}$  diameter or less ( $\text{PM}_{10}$ )

Analyte	Limit/Target/Objective value/ $\text{ng m}^{-3}$
Pb	500 (EC) / 250 (UK)
Ni	20
As	6
Cd	5



# Non-legislative metals

- We also monitor Cr, Cu, Co, Fe, Mn, V, Se and Zn
- The data from all metals measured can be used in support of:
  - producing long-term data sets to enable trend analysis
  - assessing general population exposure
  - informing health studies
  - informing policy development
  - evaluating abatement strategies
  - modelling studies for urban, traffic and land-use planning
  - Environmental Impact Assessments
- All results publicly available on [uk-air.defra.gov.uk](http://uk-air.defra.gov.uk)



Department for Environment Food & Rural Affairs

**UK AIR**

Air Information Resource

# Priority pollutants

## Lead

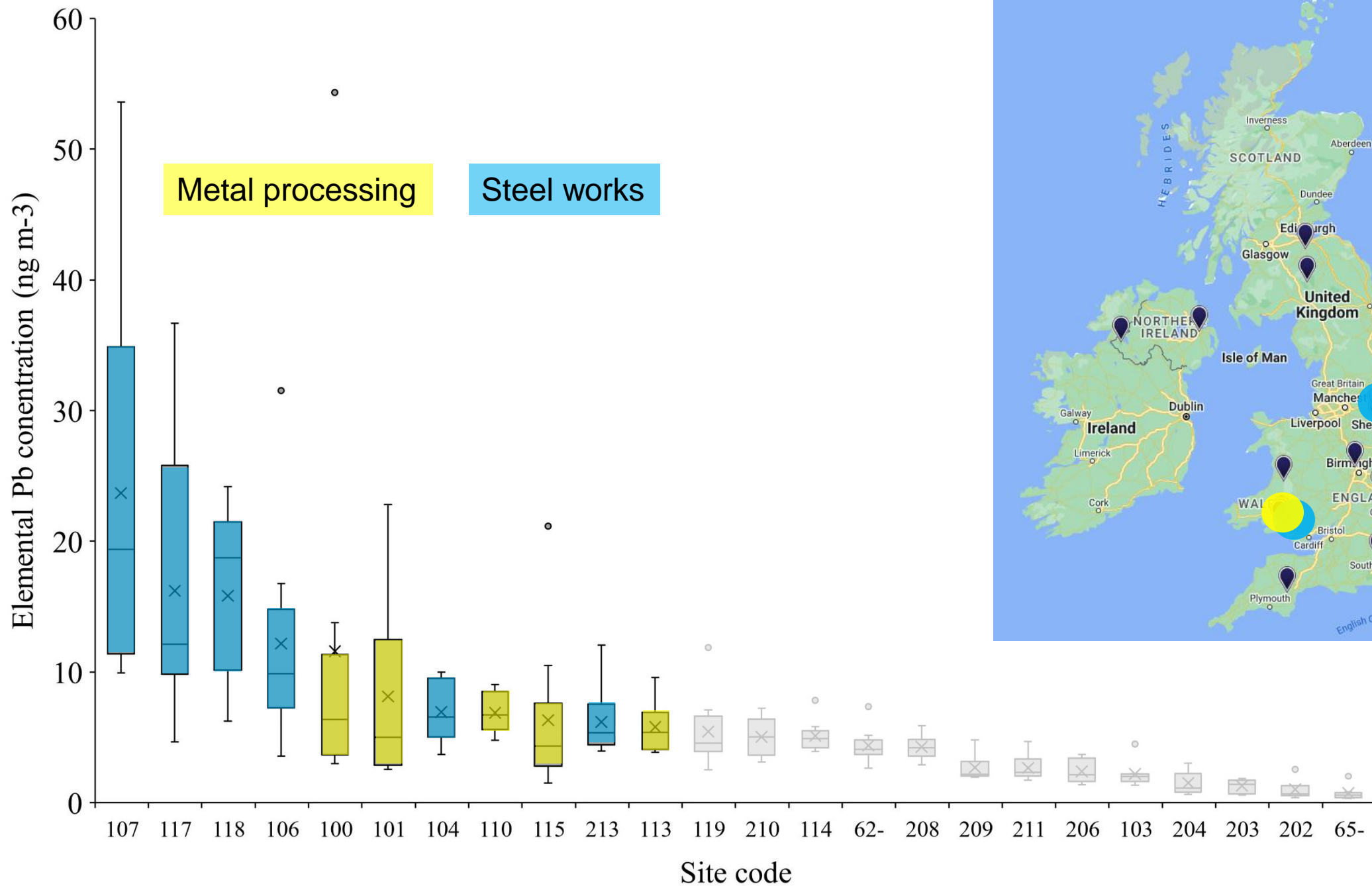
- Levels of lead in ambient air have fallen significantly in recent years
- But still significantly higher than background levels
- Knowledge of the source of this metal will help define improved removal or mitigation strategies

## Nickel

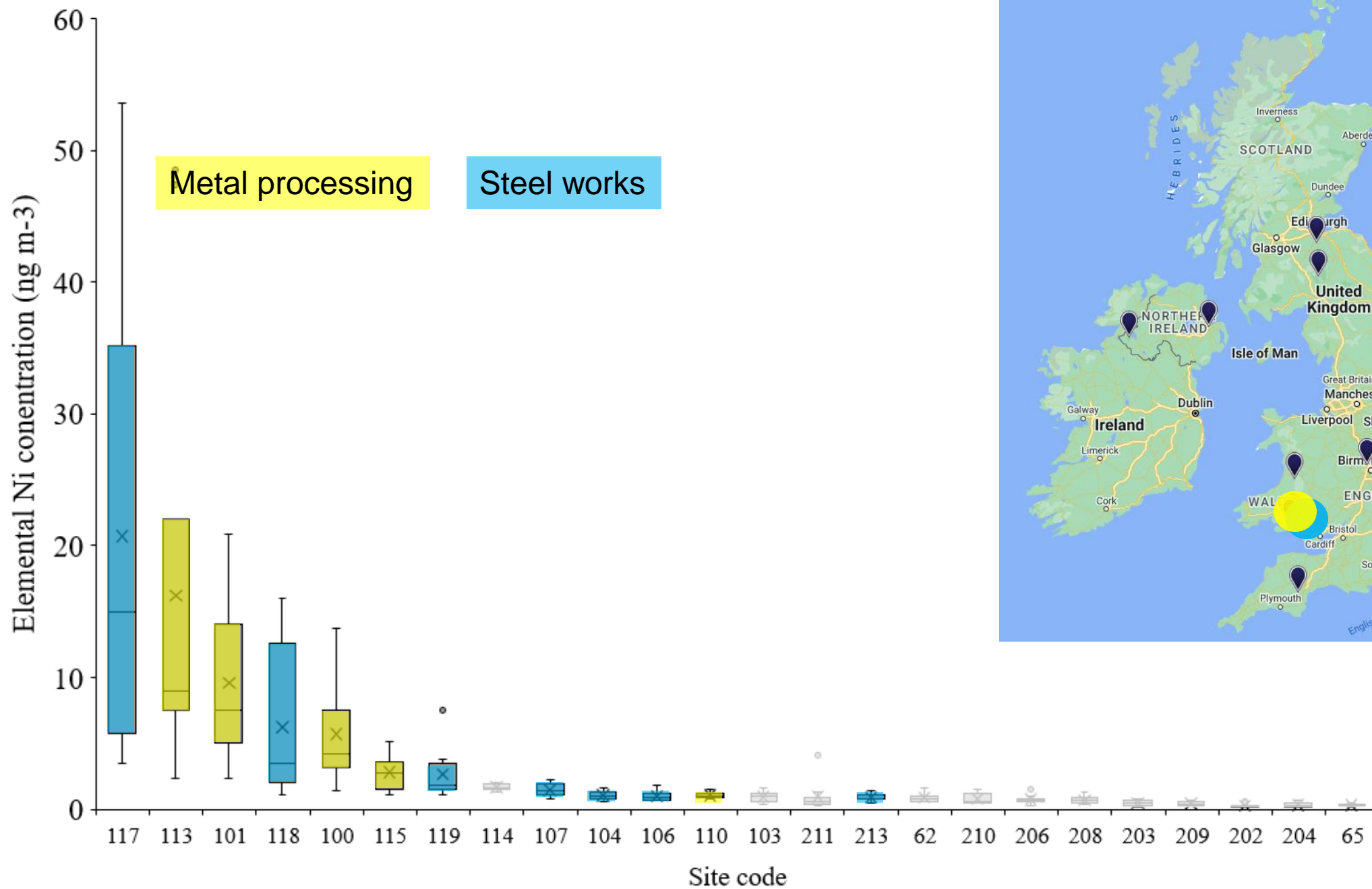
- Pollutant of key concern in some areas of the UK
- Exceeds legislated limit values in specific areas of the UK
- Improved source apportionment methods are vital to understand the origin of nickel in the air



Pb



Ni



# Pb isotope ratio measurement with ICP-MS/MS

- Agilent 8900
- NIST 981 lead wire (5, 10, 20, 50, 100 ppb)

**National Institute of Standards & Technology**

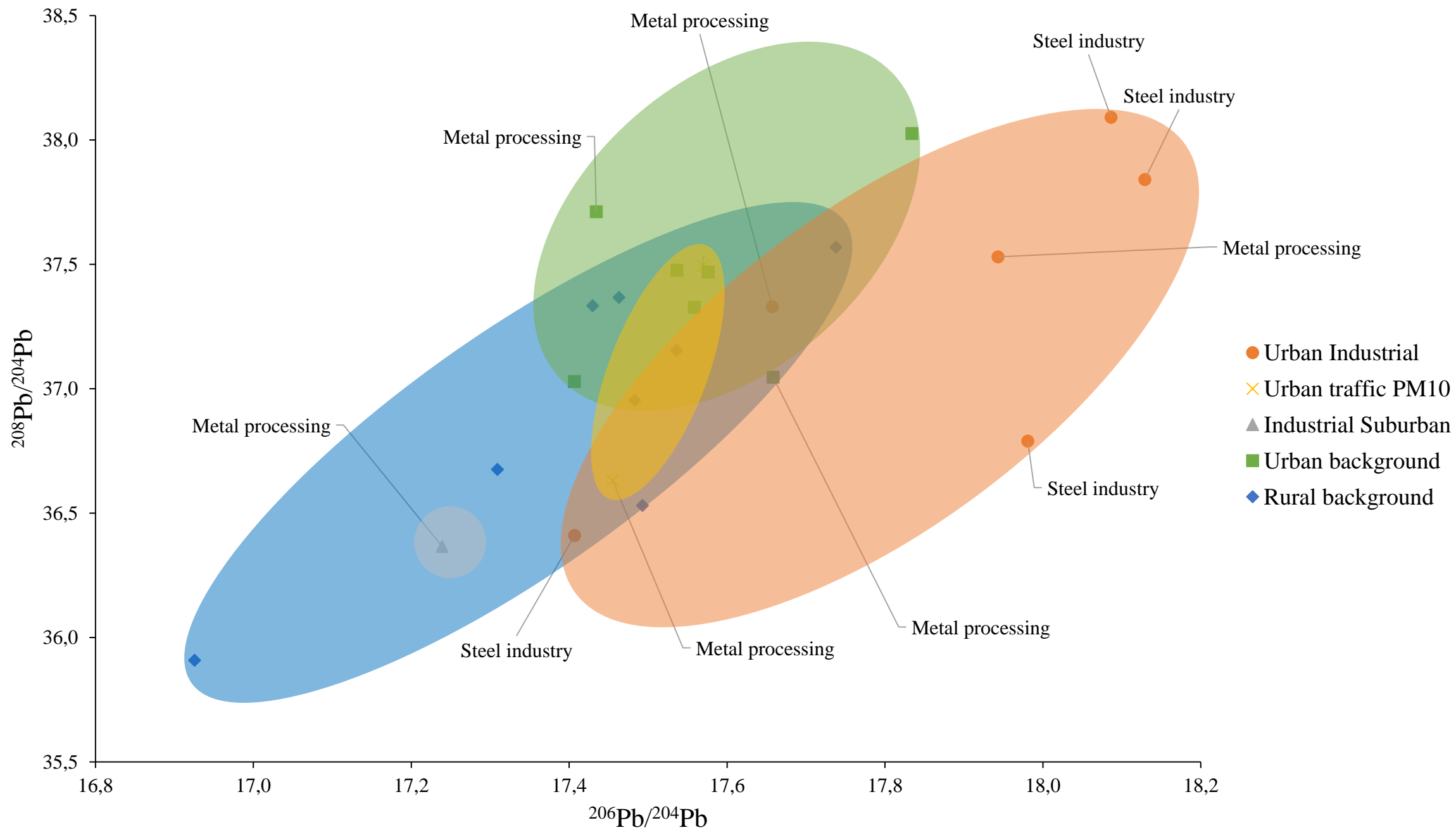
## **Certificate of Analysis**

**Standard Reference Material 981**

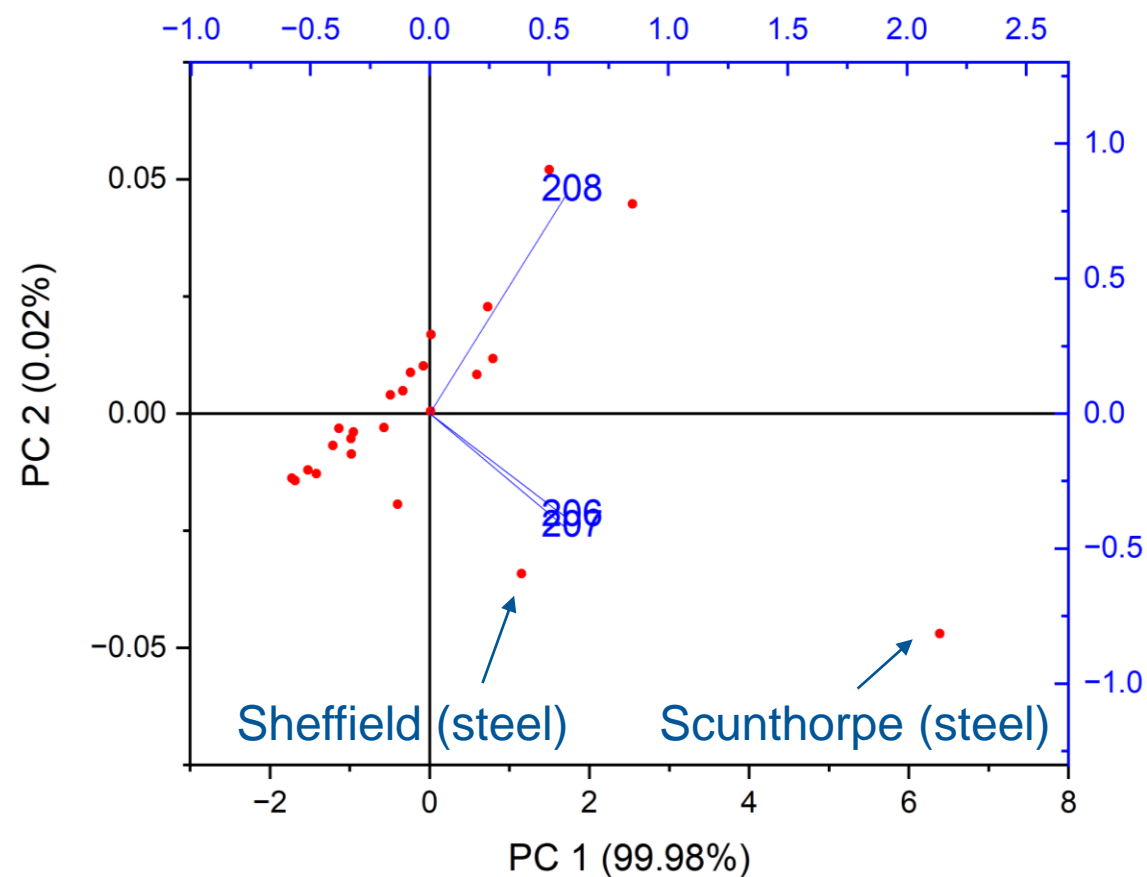
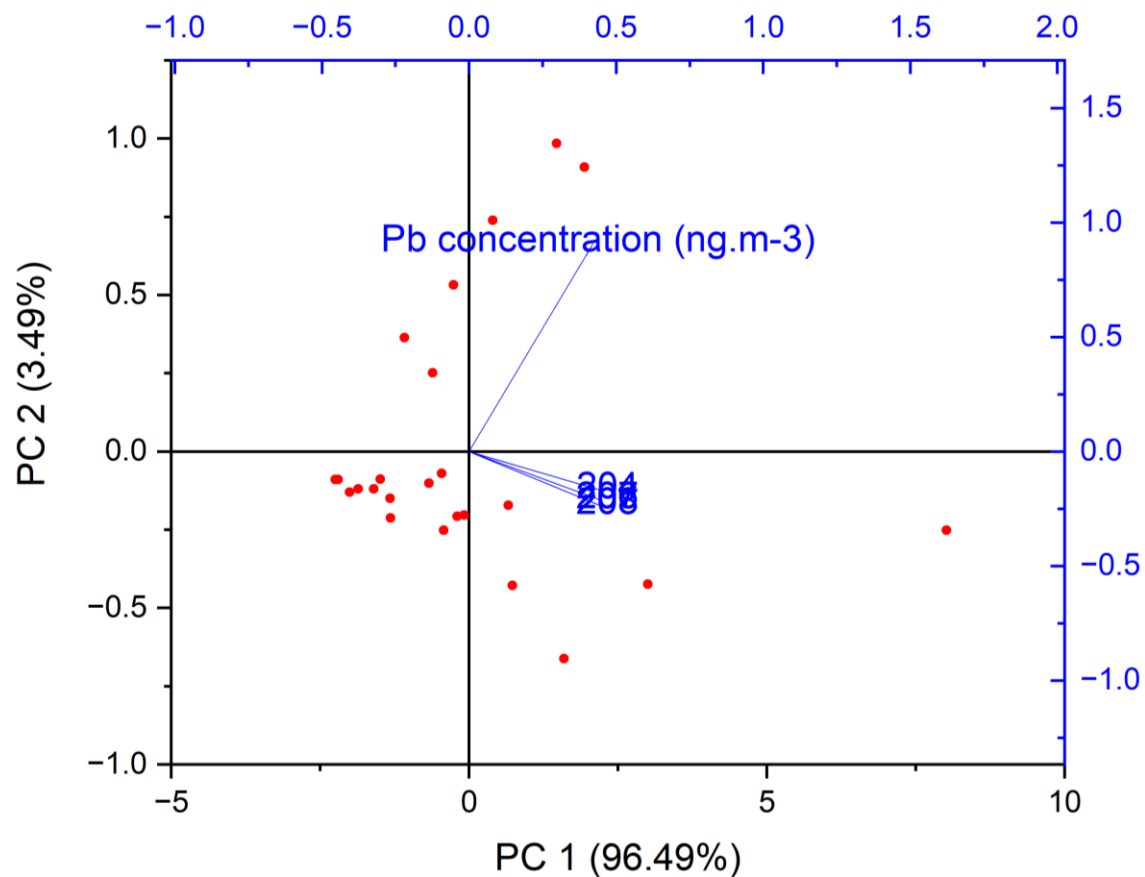
**Common Lead Isotopic Standard**

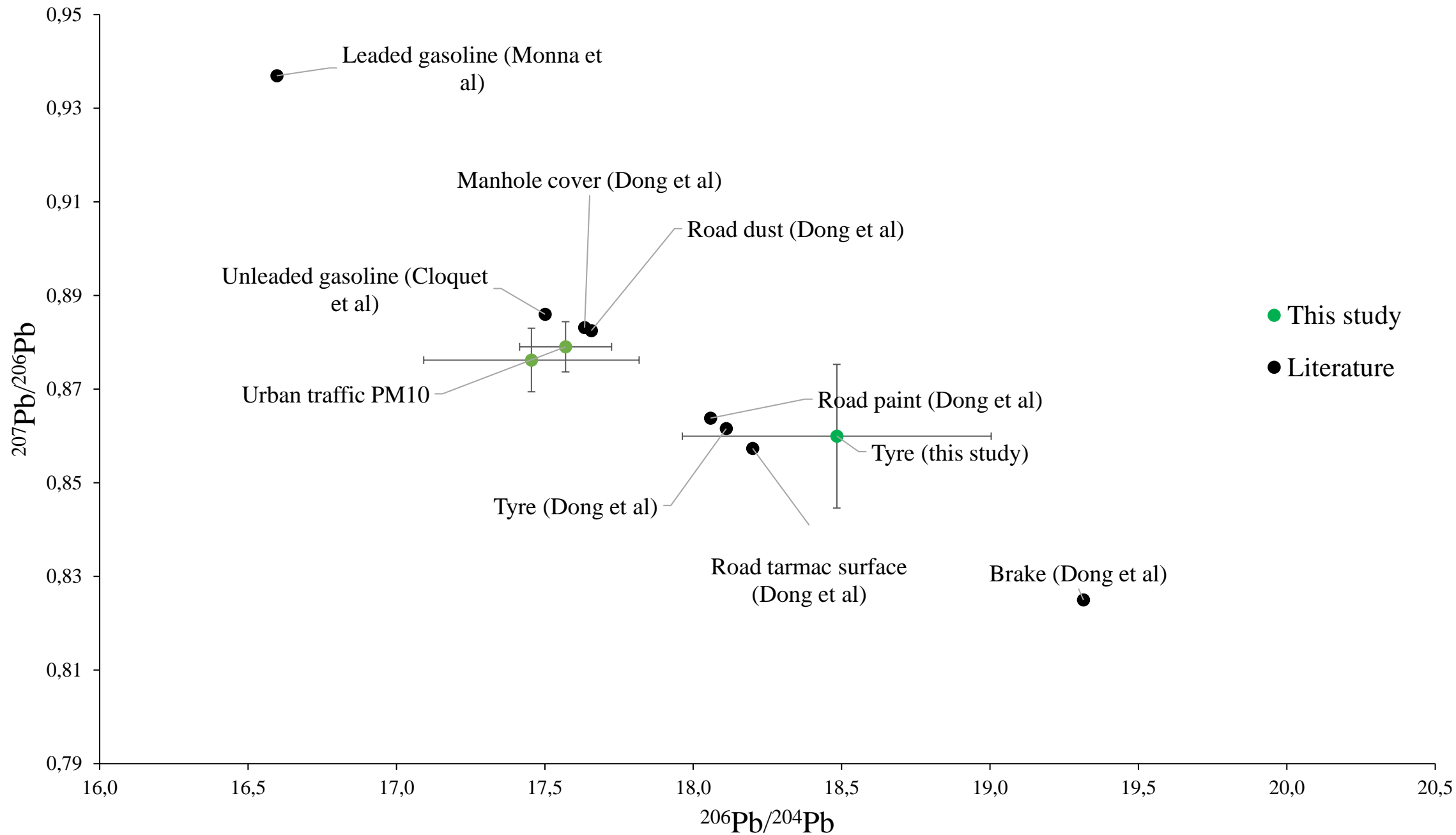
- $^{204}\text{Pb}$ ,  $^{206}\text{Pb}$ ,  $^{207}\text{Pb}$ ,  $^{208}\text{Pb}$  in no gas and He mode
- Thallium internal standard
- XLGENLINE - generalised least squares fitting software
- Validation with CRM



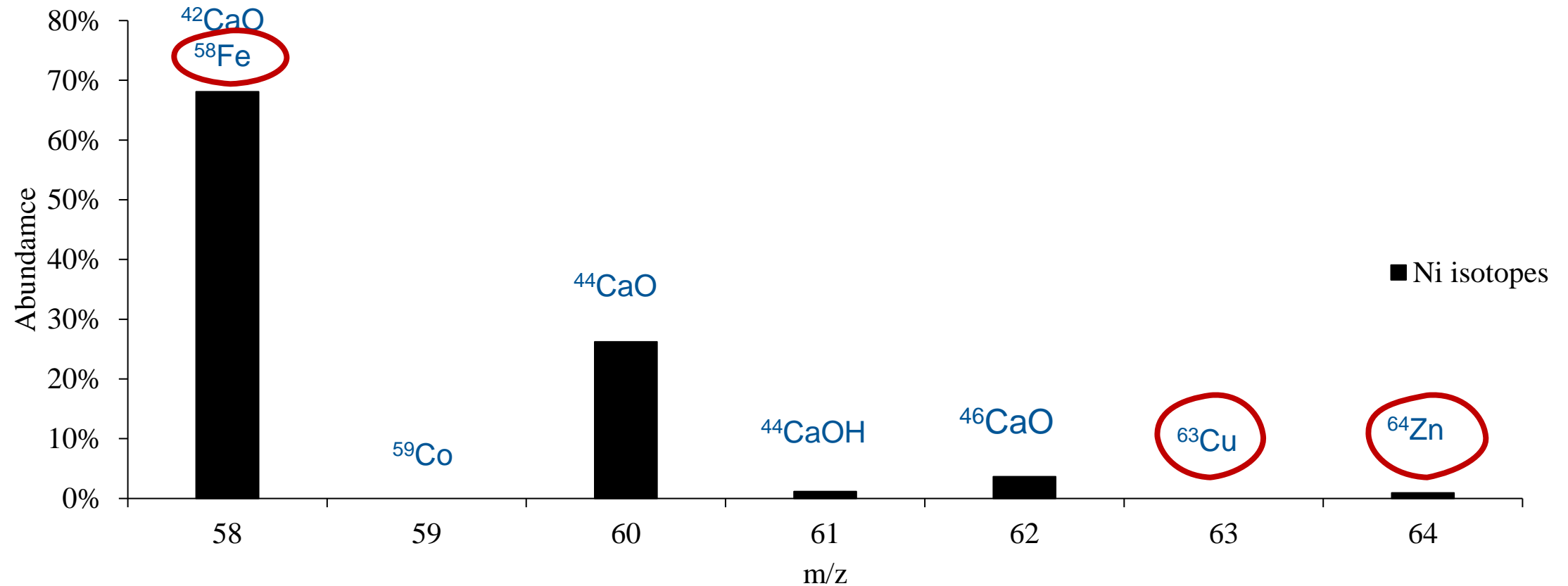


# PCA analysis





# Nickel isotopes and interferences

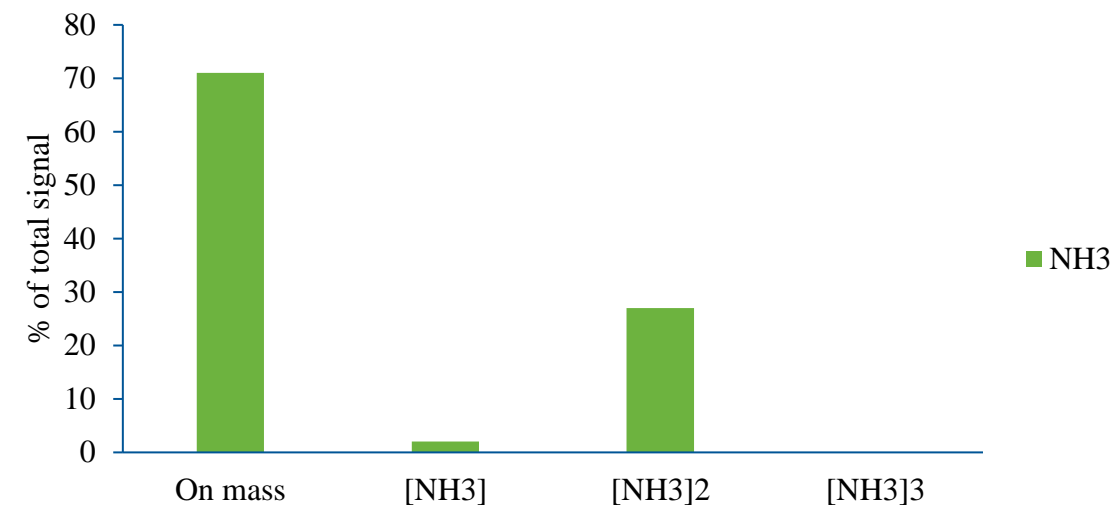
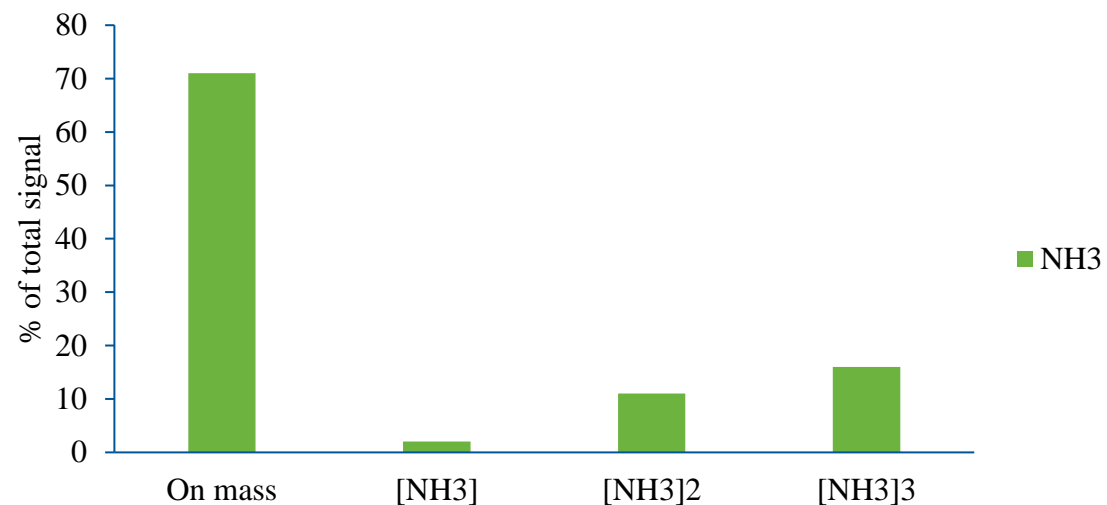


# NH<sub>3</sub> cell gas

Ni

4.0 mL min<sup>-1</sup>

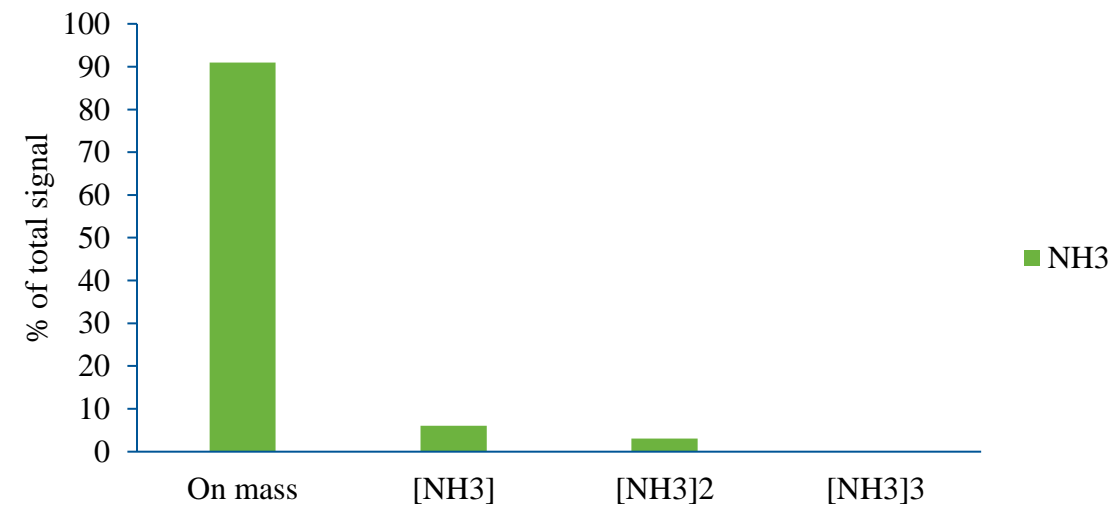
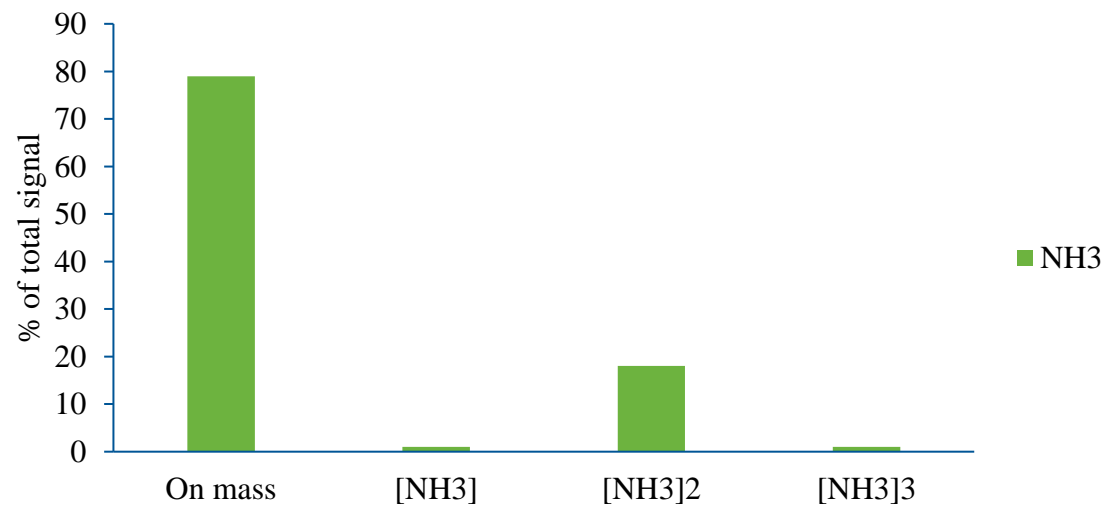
Cu



Fe

m/z + 17, +34 and +51

Zn

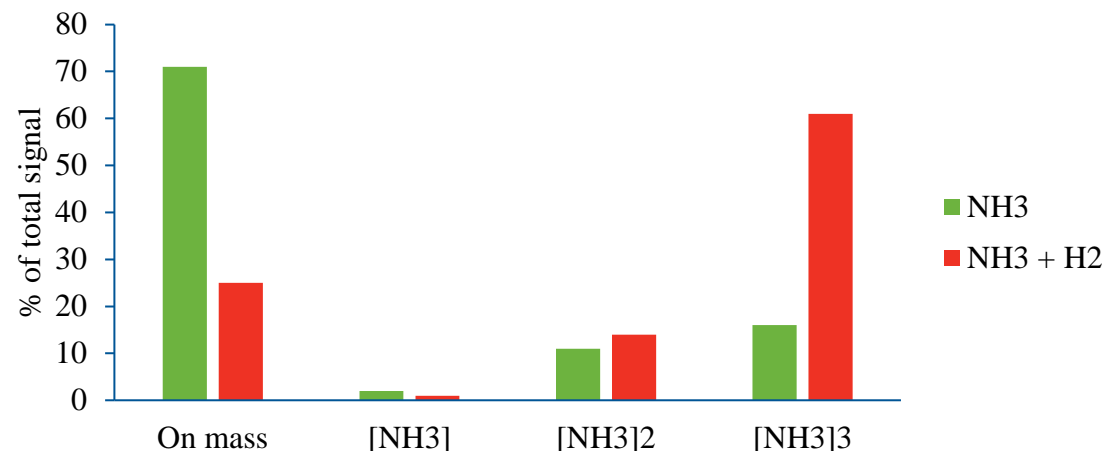




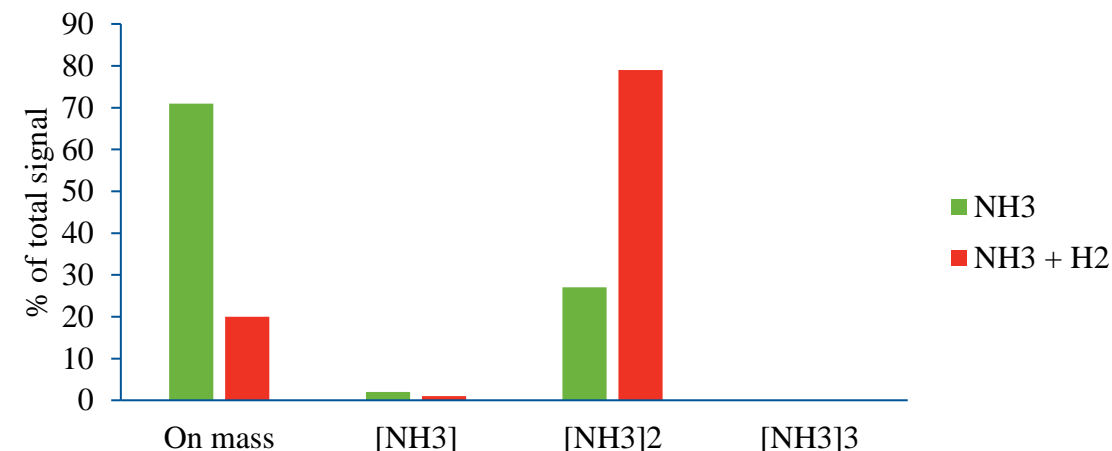
# NH<sub>3</sub> cell gas with H<sub>2</sub>

4.0 mL min<sup>-1</sup> and 6.5 mL min<sup>-1</sup>

**Ni**

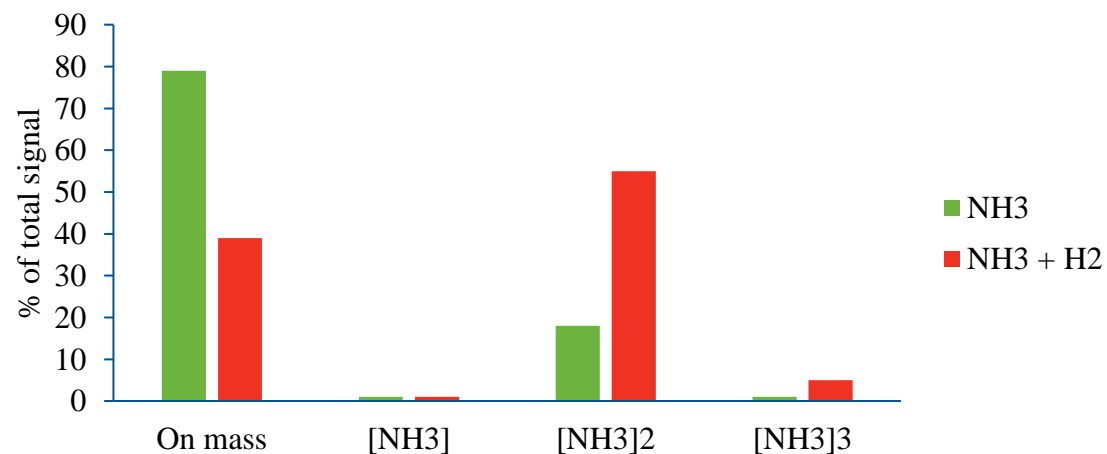


**Cu**

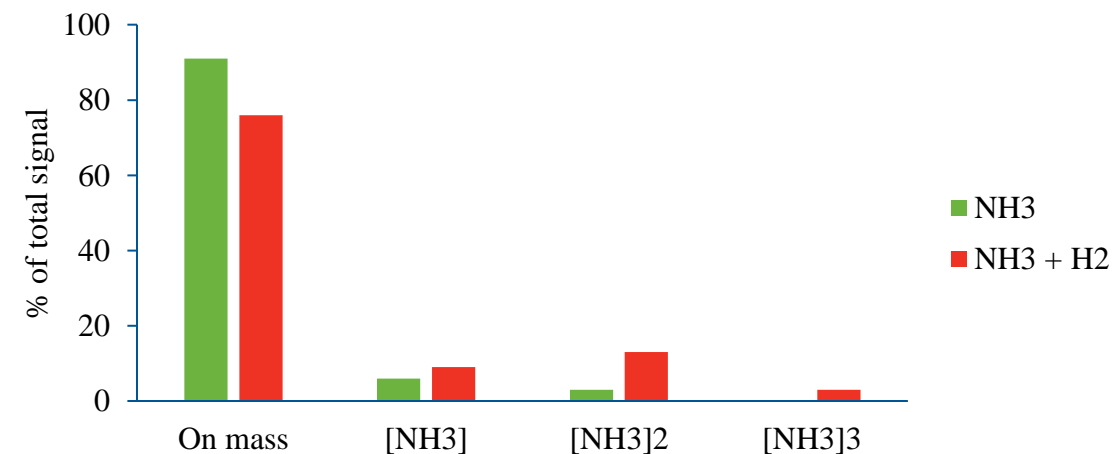


m/z + 17, +34 and +51

**Fe**

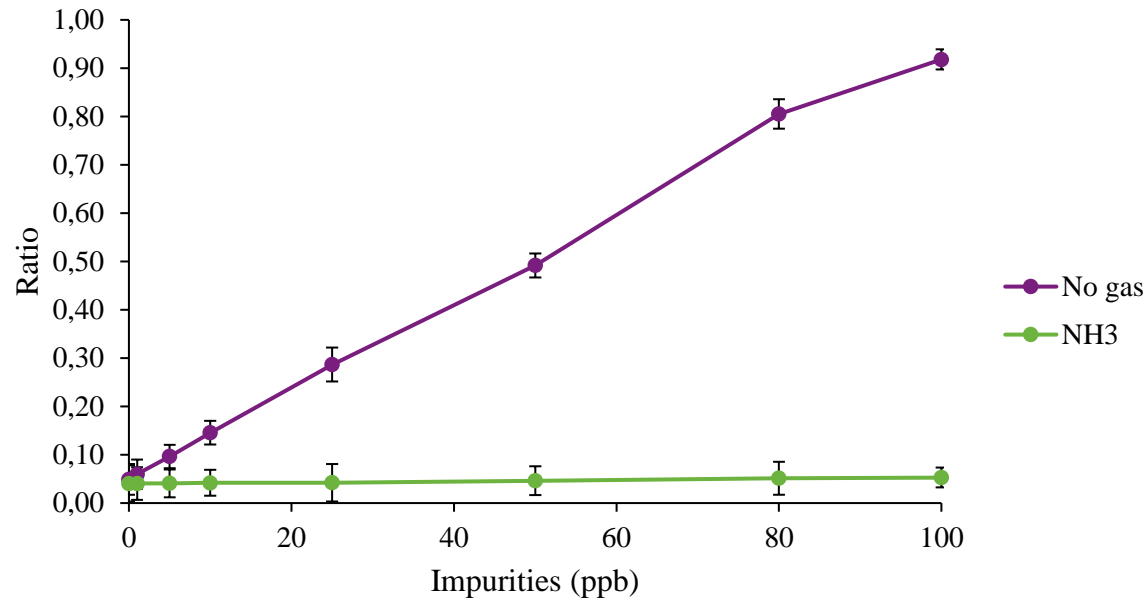


**Zn**

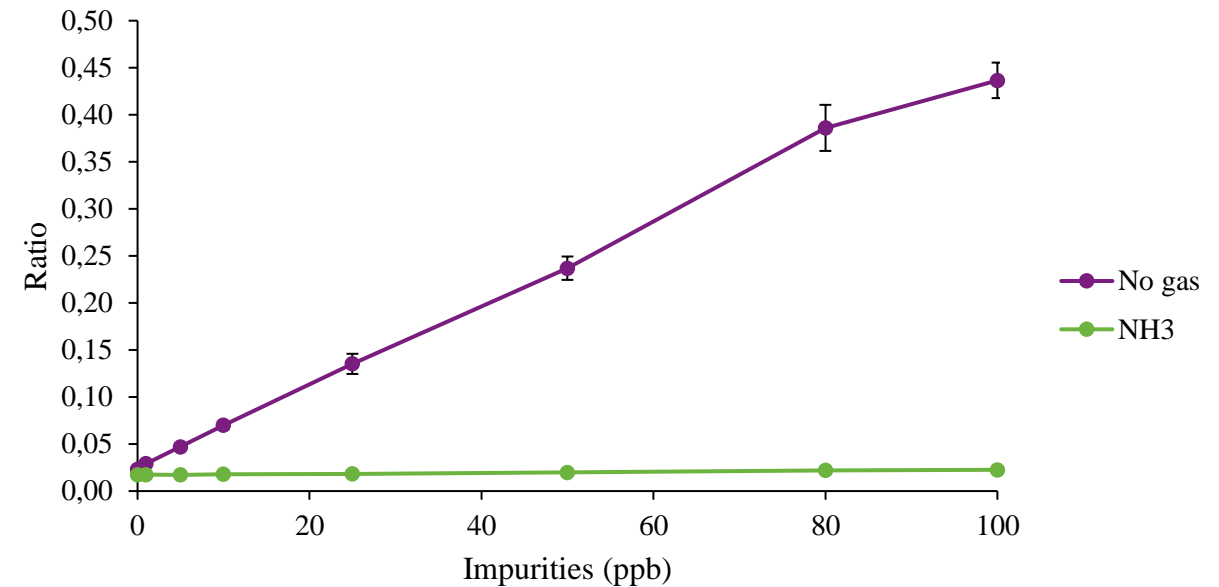


# Ni isotope ratio

$^{64}\text{Ni}/^{60}\text{Ni}$



$^{64}\text{Ni}/^{58}\text{Ni}$



- 100 ppb Ni spiked with increasing amounts of Fe, Cu and Zn
- Ni custom tune
- Mn used for an internal standard

# Conclusions & future work

- Traceable method for Pb isotope ratio developed
  - Applied to PM10 filter samples from across the UK
  - Separation seen between site types
  - Difference in site characteristics from changes in 208 relative to 206 and 207
  - Vehicle emissions in agreement with literature values
  - PMF may provide more information
- Nickel interference removal shown as in literature
  - 4.0 mL min<sup>-1</sup> NH<sub>3</sub> and 6.5 mL min<sup>-1</sup> H<sub>2</sub>
  - Isotope ratios shown to be consistent with increasing concentration of interfering elements
  - Apply method to filters samples

# Thank you

## Any questions?



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