Determination of Rhodium using Fire Assay with Co-Collectors

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OUTLINE

- INTRODUCTION
- OVERVIEW OF PGMs MARKET
- CHALLENGES ASSOCIATED WITH DETERMINATION OF RH
- METHODOLOGY AND EXPERIMENTAL RESULTS
- CONLUSION
- ACKNOWLEDGEMENTS

INTRODUCTION

❑ Background Overview of Rh

- Rhodium, one of six PGMs, is a silver-white metallic element that is highly reflective and strongly resistant to corrosion.
- Found mainly in platinum ores.
- Oxidation states: +2, +3, +4, +6 (Rh^{3+} most stable).

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OVERVIEW OF PGMs MARKET

- Used in jewellery, electronics, catalysis, and industrial coatings.
- High value: often more expensive than Pt & Pd.

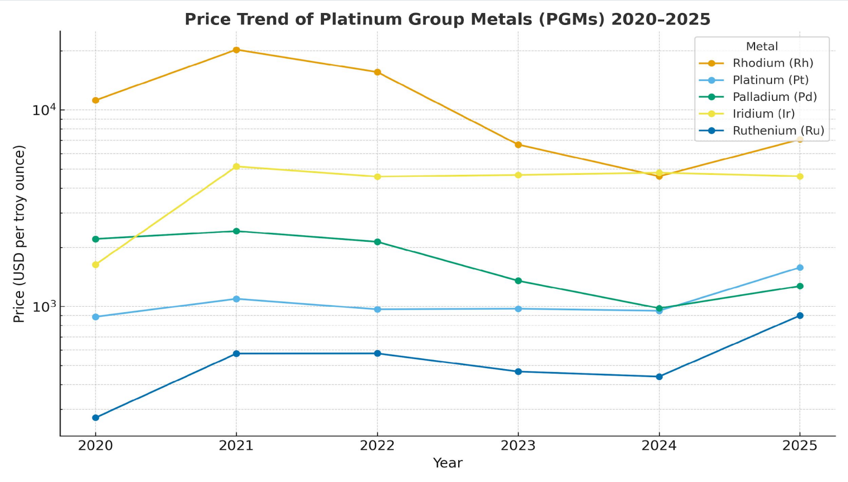

Figure 1. Price trend of Platinum Group Metals

CHALLENGES ASSOCIATED WITH DETERMINATION OF RH

- Low Natural Abundance.

- Spectral Interferences.

  - *Rhodium emission lines (e.g., 343.489 nm, 369.236 nm, 384.787 nm) often overlap with strong lines from iron (Fe), platinum (Pt), and palladium (Pd).*

- Matrix Effects

  - *The presence of other PGMs and base metals (Ni, Cu, Co, Pb) in the assay matrix can suppress or enhance the Rh signal, affecting quantification.*

- Sample Dissolution Issues

  - *Rhodium is chemically inert and resistant to acid dissolution. Complete dissolution often requires high-temperature digestion.*

CHALLENGES ASSOCIATED WITH DETERMINATION OF RH

Interaction with Other PGMs

- *Rhodium recovery can be affected by the presence of other PGMs (Pt, Pd), as they can alter the metallurgical behavior of the prill.*
- *The addition of co-collectors such as Pd, Te, Cu, or Co can improve recovery, but the interaction must be optimized carefully.*

Analytical Variability

- *Due to these challenges, the precision and reproducibility of Rh results in fire assay can be poor compared to other PGMs.*
- *Variations in recovery often exceed ± 20%, particularly without co-collector optimization.*

IMPORTANCE OF FIRE ASSAY IN THE DETERMINATION OF RHODIUM (Rh)

Efficient Preconcentration

- *Fire assay ensures complete alloying of Rh with lead or nickel sulphide collectors.*
- *Fire assay concentrates Rh into a small metallic prill, enabling accurate detection.*

Matrix Separation in High-Temperature Recovery

- *Removes silicate and base metal matrices through slag formation.*
- *Produces a clean metallic phase suitable for further dissolution.*
- *The addition of co-collectors such as **Pd, Ag, Te, Cu, or Co** can improve recovery, but the interaction must be optimized carefully.*

RESEARCH AIM

- Investigate collection of Rh by fire assay with lead flux + co-collectors

  (***Silver (Ag), Palladium (Pd), Tellurium (Te)***).

- Investigate acid dissolution methods with the open digestion method.

- Evaluate analytical sensitivity and recovery using ICP-OES

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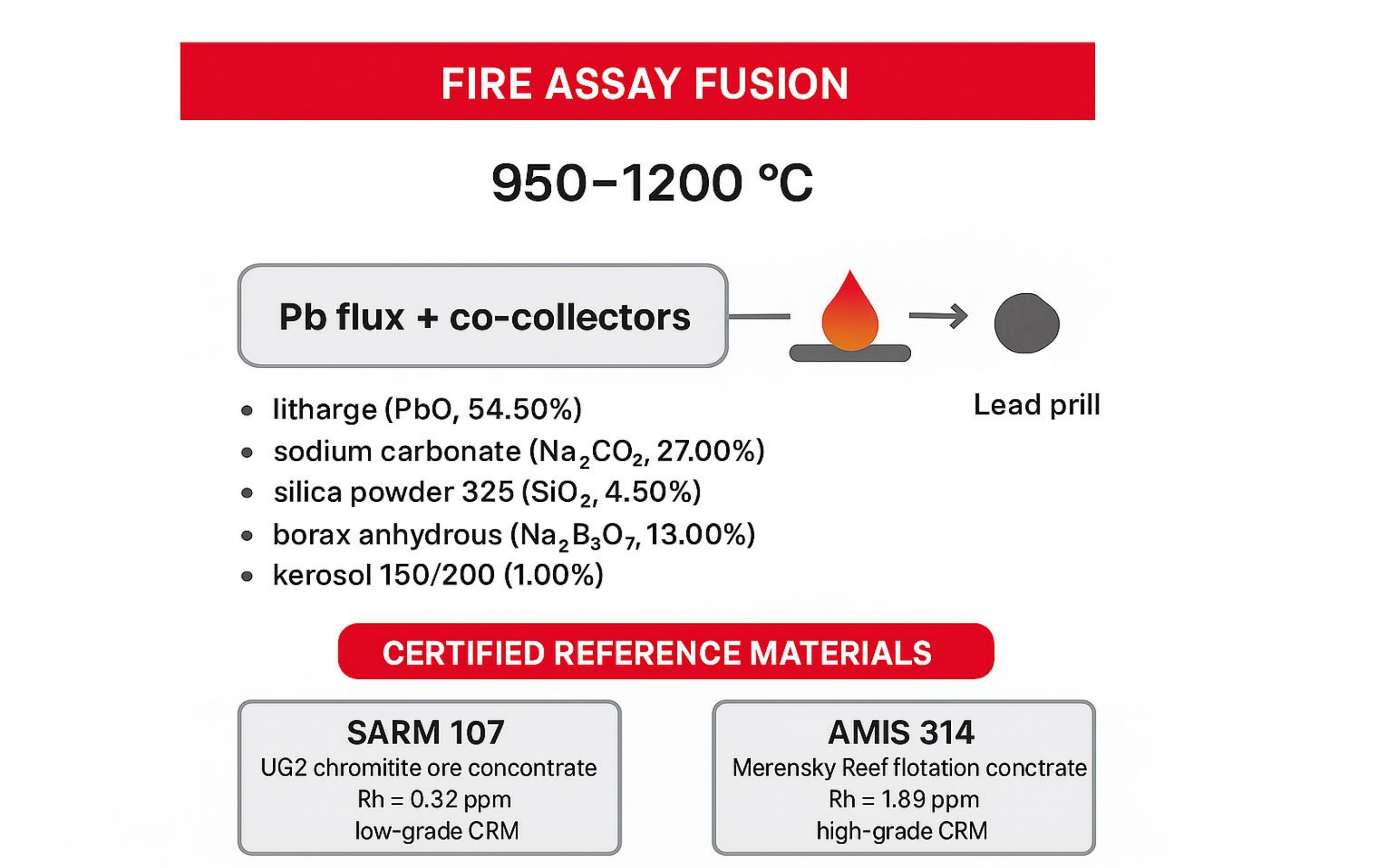
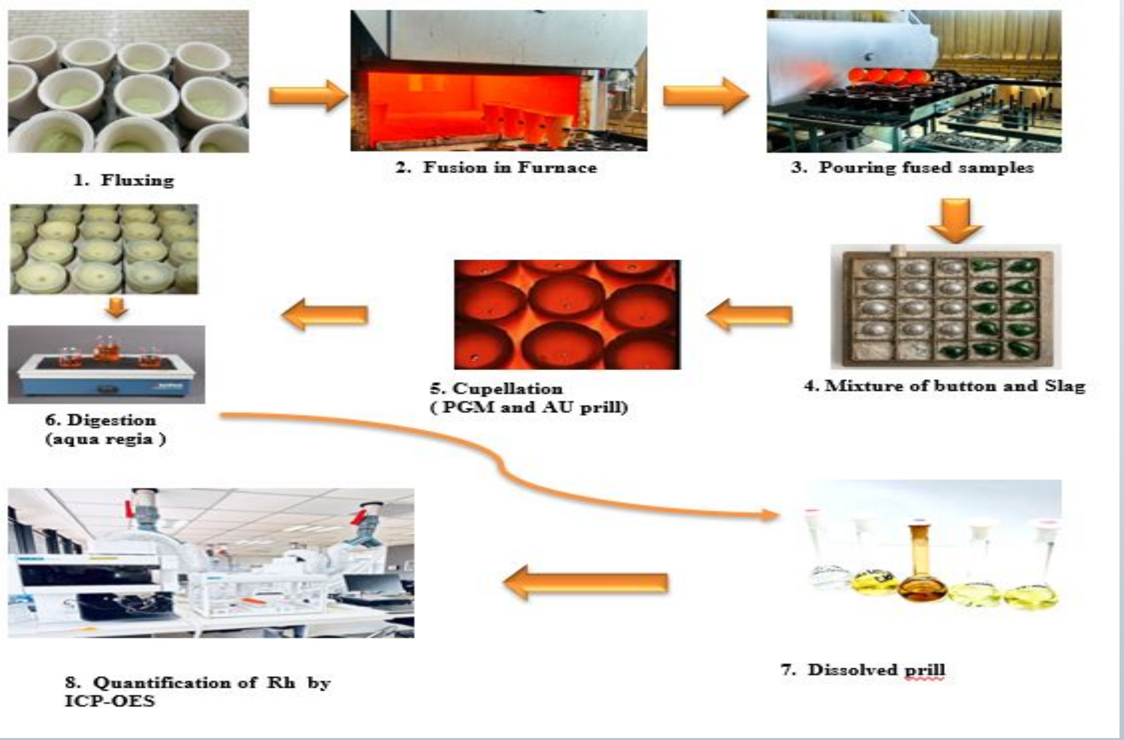
MATERIALS AND METHODS



MATERIALS AND METHODS



Cupellation Process (Scientific Expression)

Main Reaction: Pb (s) + ½ O_2 (g) → PbO (l/s)

Absorption Process: PbO (l) → PbO (absorbed in cupel)

- *As cupellation proceeds, litharge (PbO) is continuously absorbed by the magnesia or bone-ash cupel, effectively removing lead and other base metal oxides.*

Final Result: Au (s) + PGMs (s) → Metallic bead residue

Figure 2.Illustration of fire assay process for Rh determination

RESULTS

- ICP-OES was used to provided reliable quantitative results

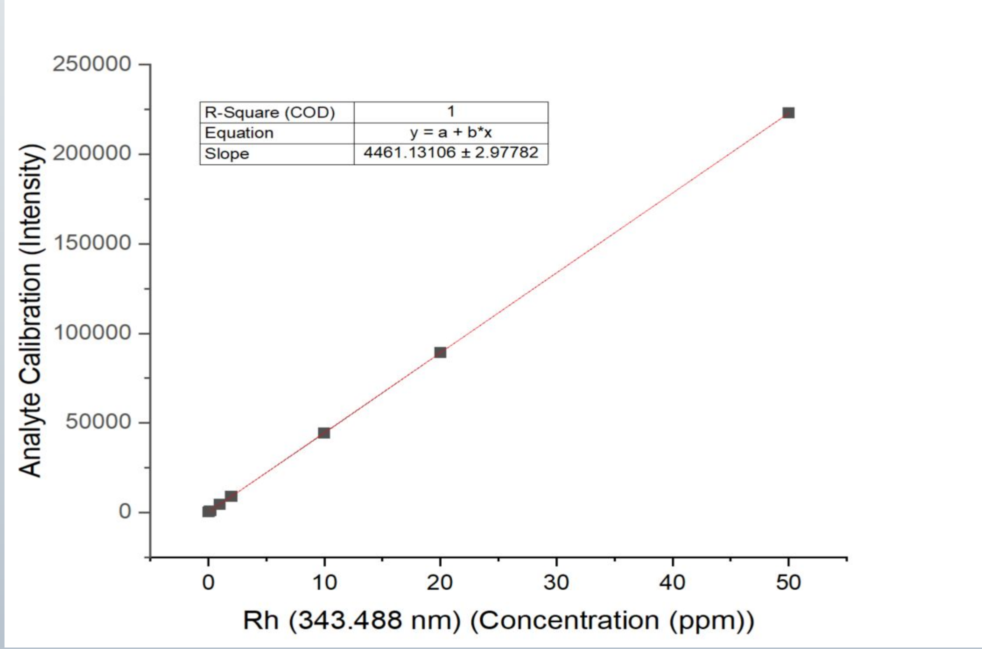


Figure 3. Analytical calibration from ICP-OES

- ICP-OES analysis with calibration 0.05–50 ppm.

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RESULTS

Summary of Rh recovery from SARM 107

Sample ID	Concentration (ppm)			
	Spike (2ml)			
	No spike	Ag	Pd	Te
SARM 107/1	0.05	0.01	0.27	0.26
SARM 107/1	0.12	0.00	0.25	0.26
SARM 107/1	0.12	0.00	0.25	0.32
SARM 107/1	0.20	0.02	0.26	0.27
Average Recovery	0.12	0.01	0.26	0.28
Accurate Value	0.32	0.32	0.32	0.32
SD	0.06	0.01	0.01	0.03
RSD	52.47	106.07	3.94	10.78
Recovery %	37,5	3.20	81.25	87.50

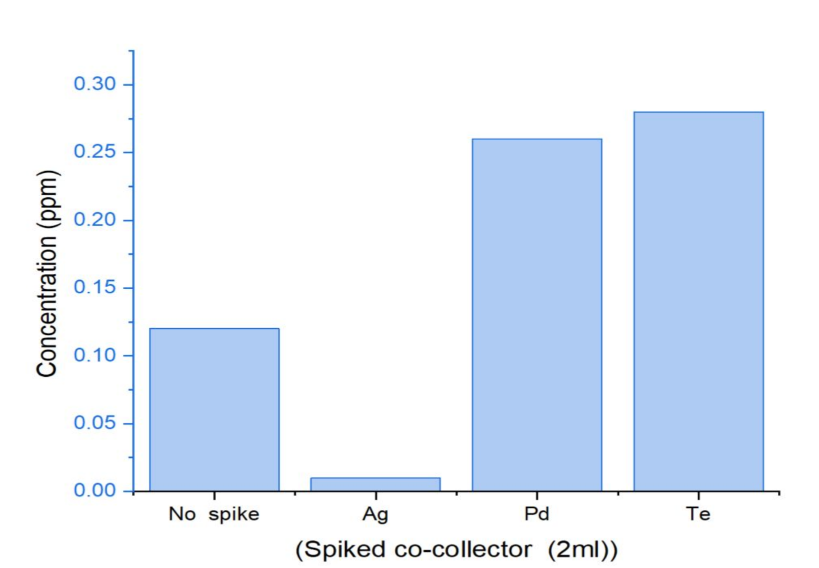

Figure 4. Average recorded concentration of Rh

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RESULTS

Summary of Rh recovery from AMIS 314

Sample ID	Concentration (ppm)			
	Spike (2ml)			
	No spike	Ag	Pd	Te
AMIS 314/1	1.12	0.03	1.77	1.63
AMIS 314/1	1.40	0.02	1.90	1.71
AMIS 314/1	1.68	0.02	1.71	1.61
AMIS 314/1	1.20	0.02	1.45	1.81
Average Recovery	1.35	0.02	1.71	1.69
Accurate Value	1.89	1.89	1.89	1.89
SD	0.25	0.00	0.19	0.09
RSD	18.44	16.66	11.01	5.43
Recovery %	71.42	1.05	90.48	90.00

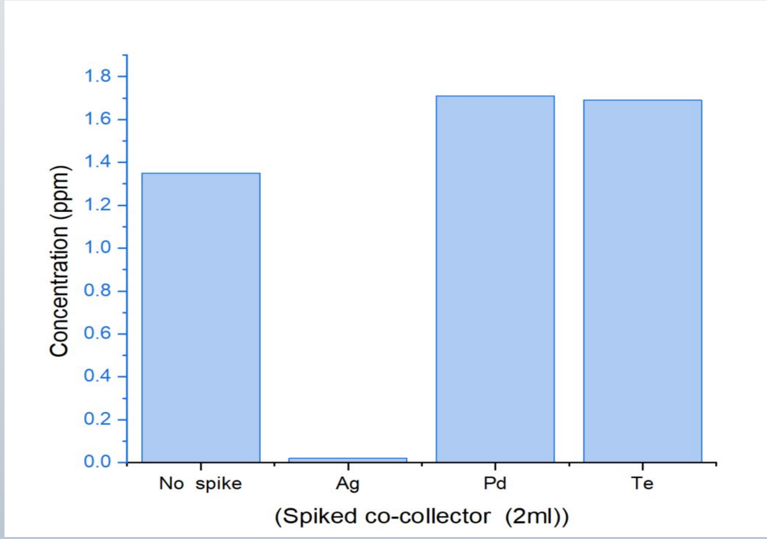

Figure 5. Average recorded concentration of Rh

CCONCLUSION

- Determination of Rh requires tailored analytical approaches.
- Co-collectors improve PGM collection and analytical sensitivity depending on interactions.
- Palladium (Pd) and Tellurium (Te) are most effective for Rh, good recovery (100–120%).
- Fire assay with lead collection + co-collectors improves preconcentration of PGMs.
- ICP-OES provided reliable quantitative results.
- Additionally, other dissolution methods such as high-pressure or closed-vessel microwave digestion can be employed to enhance recovery.

ACKNOWLEDGEMENTS

- ❑ Mintek
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THANK YOU

FOR YOUR ATTENTION

Questions and Discussion Welcome

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