



Quantification and Mineral association of Rhodium in Low-grade Ores using Inductively Coupled Plasma – Optical Emission Spectrometry

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9th International PGM
Conference

27-28 October 2025

Outline

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Background and Motivation

Geological Originality of Rhodium (Rh)

- ❑ In South African context lies within Bushveld Complex associated with Igneous layers which formed from a large-scale magmatic event
- ❑ These layers are in the economically significant zone in the cardinal direction¹:-
 - *Merensky (Western Limb)
 - *Upper Group 2 (Eastern Limb)
 - *Platreef (Northern Limb)
- ❑ This Complex is known as the global's largest platinum group metal (PGM)-resource

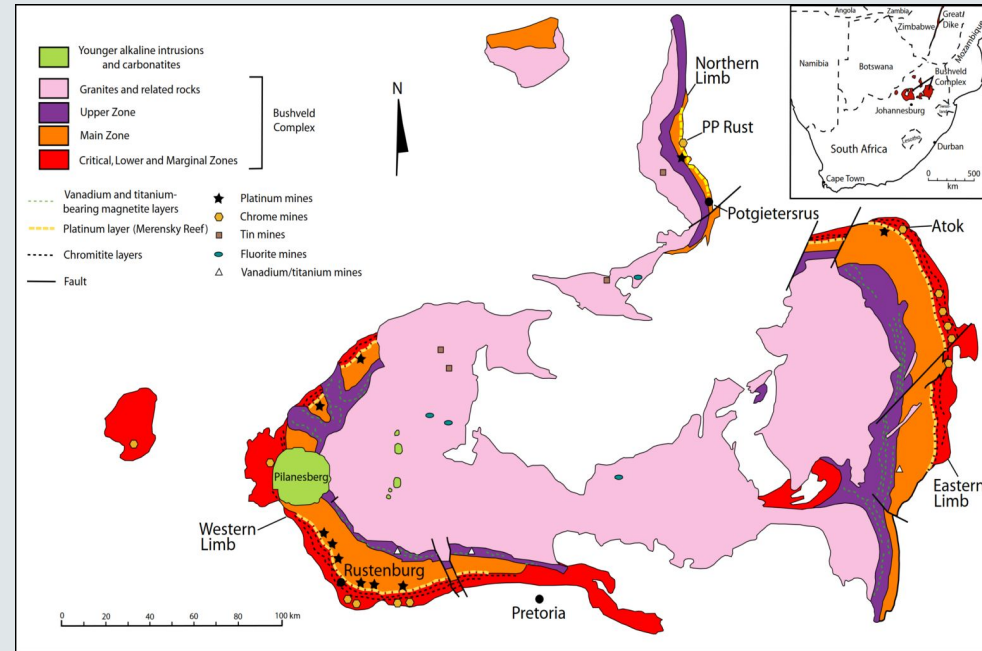


Fig 1. Geologic map of the Bushveld Complex, showing mines, limbs, and different zones

¹H. Tang, et al., (2023) *J. Environ. Chem. Eng.*, doi: 10.1016/j.jece.2023.110237

Global Rh Market Context

- ❑ The Bushveld Complex contains 75% Pd, 54% Pt, and 82% Rh including other vast reserves of Cr, V, Sn, Ni, Cu, and Co
- ❑ Global demand for Rh is projected to exceed 1 million ounces in 2024, with automotive catalysts accounting for over 65 % of this demand²
- ❑ This market volatility underscores the need for accurate analytical methods
- ❑ Fire assay remains the industry standard which requires optimisation to achieve reproducible Rh recovery

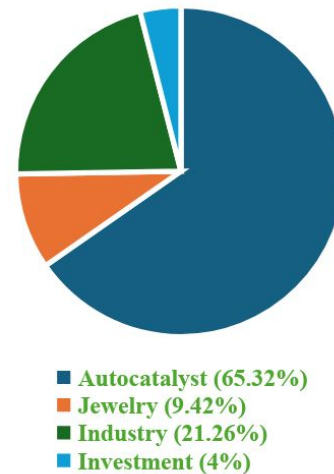


Fig 2. Global Rh demand by sector

Aim and Objectives

To determine parameters for Rh quantification in the major layers of Bushveld Complex such as Merensky (Amis 314), UG2 (SARM 189), and Platreefs (Amis 768)



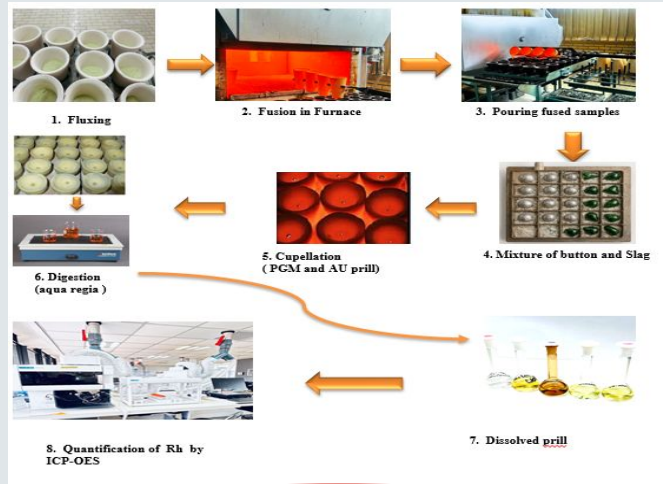
Objectives of the study:-

Assessment of particle size distribution for homogeneity determination

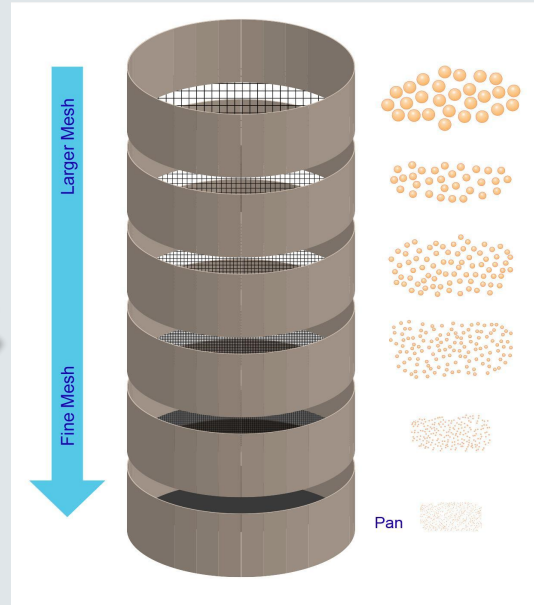
Mineral association characterisation using electron microscope coupled with energy dispersive X-ray

Assess figures of merit to determine robustness of the method for accurate analysis of Rh-ore samples

Methodology



Classical Fire Assay Process



Particle Size Distribution



Microscopic imaging analysis

Results and Discussion

Classical Fire Assay and ICP-OES Analysis

Figures of merit

***Accuracy (95-104%)**

***Linearity ($R^2 = 0.999$)**

***Reproducibility (5-10%)**

***Detection limit (0.1)**

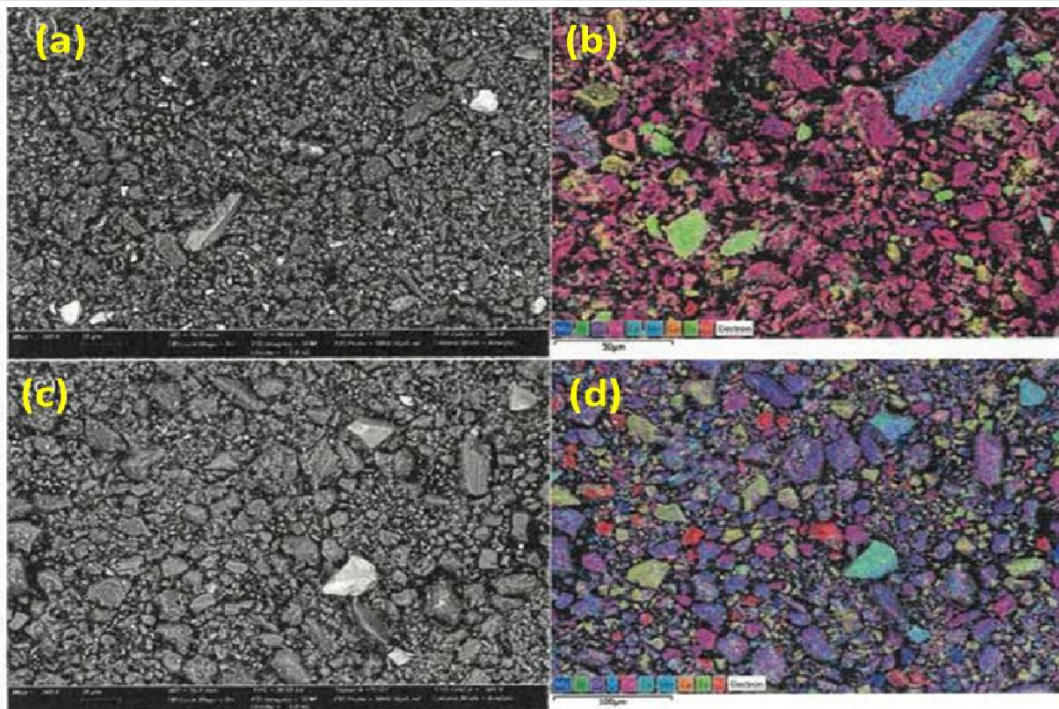
*** Spectral and non-spectral correction**

Table 1: Summary of Rh results and statistical analysis of CRM from Bushveld Complex reefs

Sample ID	Rh (ppm)	Sample ID	Rh (ppm)	Sample ID	Rh (ppm)
Merensky (Amis 314/1)	1.813	Platreef (Amis 768/1)	0.181	UG2 (SARM 142/1)	1.81
Amis 314/2	1.82	Amis 768/2	0.176	SARM 142/2	1.82
Amis 314/3	1.773	Amis 768/3	0.107	SARM 142/3	1.77
Amis 314/4	1.816	Amis 768/4	0.18	SARM 142/4	1.82
Amis 314/5	1.802	Amis 768/5	0.256	SARM 142/5	1.80
Accurate value	1.89	Accurate value	0.189	Accurate value	0.18
Recovery%	96.2	Recovery%	104	Recovery%	96.2
Average	1.82	Average	0.196	Average	0.185
RSD	1.0441	RSD	1.93	RSD	4.71

***Rh in PGM-bearing ore samples were analysed with concentrations ranging between 2.5-65 mg/L**

Mineral characterisation and Particle Size Distribution



- Merensky: Dominated by Anorthite ($\text{CaAl}_2\text{Si}_2\text{O}_8$)
- UG2 and Platreef: High Silica (SiO_2), Fe oxides, Mg-bearing chromite
- SEM-EDX confirms Rh association with silicate and chromite gangue

Particle Size Distribution

- 90% of particle size $\leq 75 \mu\text{m}$ indicates homogeneous analytical sample
- Finer grind promotes full fusion in the fire assay and accurate PGM recovery

Fig 3. SEM-EDX of Merensky (a-b) and Platreef (c-d)

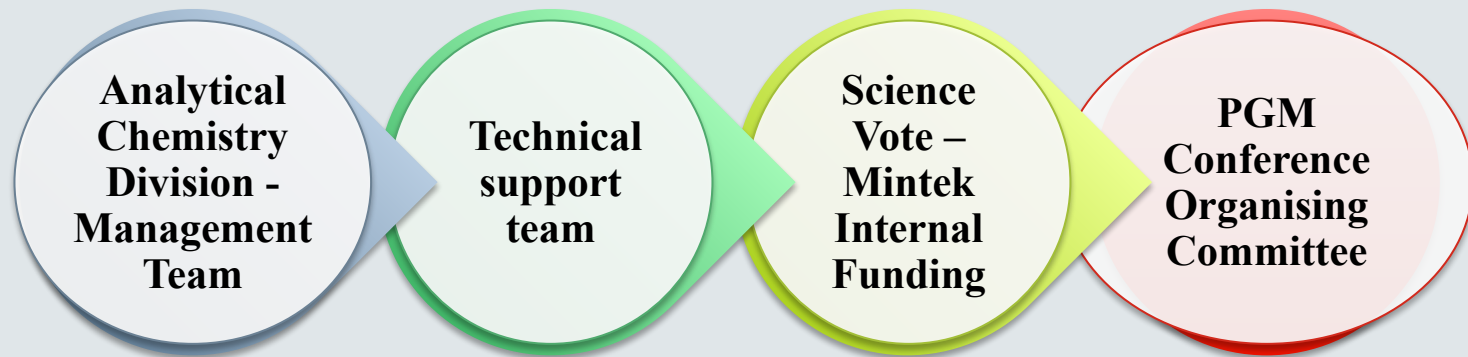
Key Findings and Broader Impact

□ In summary, our study demonstrated that:-

- * The **343.488 nm wavelength** is optimal for Rh detection with ICP–OES
- * The developed method achieved **recoveries between 90 and 110%**
- * It provided excellent **reproducibility** and **low detection limits** suitable for trace analysis
- * Correlations between mineralogy and Rh occurrence were successfully established, making this a reliable tool for **low-grade ore quantification**

- ❖ The method support PGM beneficiation goals and strengthens Mintek's analytical innovation capacity
- ❖ Moreover, it improves process control and analytical confidence while enabling mine-to-refinery accountability

Acknowledgements



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