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THE SOUTHERN AFRICAN INSTITUTE OF MINING AND METALLURGY

Abstract Book

27-28 October 2025
Sun City, Rustenburg, South Africa

THE SOUTHERN AFRICAN INSTITUTE OF MINING AND METALLURGY JOHANNESBURG 2025

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FOREWORD

Building on the success of previous events since its inception in 2004, the Platinum Conference Series continues to address the challenges and opportunities facing the global platinum group metals (PGMs) industry. As the sector faces increasing demands, from technological innovation and decarbonisation to cost management and market volatility, the 9th International PGM Conference offers a critical platform for addressing these challenges head-on. The main theme for the conference is 'PGMs – Enabling a Cleaner World'; the conference seeks to drive competitiveness, relevance and self-determination of the PGM industry through strategic positioning. Guided by an expert Organising Committee and informed by insights from the industry, this year's conference will delve into various topics designed to spark meaningful dialogue to drive innovation at every level of the PGM value chain and maintain competitiveness in a rapidly changing global landscape. Attendees can expect high-quality technical papers and presentations, robust networking opportunities, and strategic insights that help shape the future of the industry. Now more than ever, the PGM industry needs fresh ideas, collaborative partnerships, and forward-thinking strategies to remain relevant. Whether you're an academic, industry professional, sponsor, or policy leader, your participation will contribute to a dynamic exchange of expertise and solutions that can safeguard the sector's long-term success. Join us as we explore cutting-edge developments, address the industry's most pressing issues, and shape a sustainable, competitive future for the PGM industry. Be part of this dynamic event and help shape the future of the platinum and PGM sector. We look forward to your participation to ensure that this conference continues to be the premier platform for exchanging knowledge, ideas, and best practices in the PGMs space.

B.S. Xakalashe
Chairperson: Organising Committee
M.A. Mello
Co-Chairperson: Organising Committee

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Conference Chairperson

Buhle Sinaye Xakalashe

Head: New Technology (Pyrometallurgy)
Mintek, South Africa

Buhle Xakalashe holds a BEng degree in Chemical Engineering from the University of Pretoria, which was funded through a Mintek bursary. He was seconded by Mintek to undertake an MSc Eng in Materials Technology with a specialisation in silicon and ferroalloy production at the Norwegian University of Science and Technology (NTNU). He is a member of the Technical Programme, and the Diversity and Inclusion committees of the Southern African Institute of Mining and Metallurgy (SAIMM). He participates in organising numerous technical and non-technical conferences in the Minerals industry both locally and globally. He has participated in organising a few of the international forums on High Temperature Minerals Processing (HiTeMP) as an international steering committee member, including the upcoming HiTeMP-5. His publications to date, for which he has been a co-author, include over 40 peer-reviewed papers divided into publications in conference proceedings presented at international conferences, and journal papers published in leading international journals in his field. Buhle is currently the head of New Technology in the Pyrometallurgy Division at Mintek.

Buhle has over 20 years of research and development experience in the field of pyrometallurgy from the following local and global institutions: Mintek (South Africa), NTNU/SINTEF (Norway), RWTH Aachen University (Germany), KU Leuven (Belgium) and the National Technical University of Athens (NTUA) (Greece). He has been involved in metallurgical projects covering a range of commodities. He has industrial experience through a stint at TRONOX Namakwa Sands' DC arc furnace operation for the production of high TiO_2 slag and pig iron. Furthermore, he has experience in hydrometallurgical processing. He has passion for the circular economy, particularly circular economy strategies for batteries.

Conference Co-Chairperson

Madimetja Antony Mello

Director
Vuuma

Antony began his career as a Metallurgical Engineer at AngloGold Ashanti, focusing on core production processes and leading significant improvement strategies. Driven by a passion for business and strategic management, he pursued further education, completing a Postgraduate Diploma in Management followed by a full-time MBA in 2017. Antony joined Vuuma Collaborations in 2018 and is currently the Operations Director, where he spearheads the execution of the operational strategy and leads teams in applying systems thinking methodologies to enhance productivity and overall business performance, primarily within the mining and minerals sector.

Keynote Presenters

Mzila Mthenjane

CEO
Minerals Council South Africa

Mr. Mzila I. Mthenjane ("Mzila") is the CEO of the Minerals Council South Africa ("MCSA"), the Advocacy and Impact group whose members represent 90% of South Africa's mineral output and employ close to 480 000 people . He was previously the Executive Head for Stakeholder Affairs at Exxaro Resources Limited. He has more than 30 years' combined experience in the resources business (Gold, Platinum and Coal) and investment banking (Corporate and Project Finance).

He has held various board positions as non-executive director in various entities including Pamodzi Gold Limited, Fraser Alexander, Impact Catalyst, Merafe Resources, and Student Support Programme. He was on the Exxaro Executive Committee, intimately involved in stakeholder engagements and strategy.

He is the current Chairman of the Board of the Impact Catalyst and is the former Chairman of the Wits University Mining Engineers Association (WUMEA) and the former President of the South African Institute of Mining and Metallurgy (SAIMM).

Mr. Mthenjane holds a BSc degree in Mining Engineering from the University of Witwatersrand (Wits). He has completed various leadership development training including the Senior Management Development Programme from the Graduate Institute of Management and Technology (GIMT), the ABSIP leadership programme with GIBS and Advanced Management Programme (AMP), with INSEAD.

Henk de Hoop

CEO
SFA Oxford

Henk de Hoop is a mining engineer and Chartered Financial Analyst and is Chief Executive Officer of SFA (Oxford) Ltd. SFA provides bespoke, independent intelligence and consultancy services on PGM markets and a variety of other strategic metal markets. Henk has a proven track record as a top-ranked investment analyst, having analysed companies and commodities in detail in the gold, coal, base metals, diamond and PGM sectors as a stockbroking analyst for 12 years. Henk spent the next 14 years as a resources sector investment banker, getting involved in equity and debt capital raisings and M&A advisory for a wide variety of mining companies across the commodity spectrum, and he has an authoritative understanding of commodity markets, valuations and relationships across the value chain.

Johan van Royen

Head of Concentrator Technology
Valterra Platinum

Johan obtained a Chemical Engineering degree from the University of Pretoria in 1996 and has worked in the mining industry for the past 29 years.

He joined the industry with Mintek's Biotechnology Division 1997 where we worked in in the field of bacterial leaching of base metals. He pursued his interest in hydrometallurgy throughout the early 2000's in the base metals industry in Southern & Central Africa with contributions on the disciplines of technology development, project development & execution, and operations management.

Johan joined AngloAmerican in 2009 with whom he has held several technical and managerial roles into 2025; his association with AngloAmerican afforded him the opportunity to work with Anglo Base Metals, Anglo Platinum, Anglo Coal, DeBeers, Kumba Iron Ore, Iron Ore Brazil, and Niobium & Phosphates Brazil.

Johan recently joined Valterra Platinum where he holds the position of Head of Concentrator Technology.

Andre Mulder

Group Metallurgical Manager
Northam Platinum

Andre Mulder, based in South Africa, is currently the Group Metallurgical Manager at Northam Platinum. Andre Mulder brings experience from previous roles at Northam Platinum, Emerald Sustainable Solutions (Pty) Ltd and Impala Platinum. Andre Mulder holds a National Higher Diploma in Metallurgical Engineering received from the Tshwane University of Technology. With a robust skill set that includes metallurgy, operational management, process engineering, project development and execution and more.

Professor Michael Henry Solomon

Professor Solomon is a mining engineer of 45 years of experience in the gold, platinum, diamond and coal sectors. His career has spanned a balance between production mining, consulting and advisory, project development, capital raising and policy development. From a sustainability perspective he specialises on the economic diversification and decarbonisation of mines, but from commodity and investment risk is also knowledgeable on the mining of precursor battery minerals. He has lectured widely on Mining Investment Risk focussing on the supply-side factors of operational risk, host country political risk and geopolitical risk.

Since the political transformation on South Africa commenced in 1990, he has been integrally involved in the development of government policy and was a member of the ANC Minerals and Energy Group drafting team for the post-transition South African mining policy from 1992-1994 and seeing that policy into the promulgation of the country's Mineral and Petroleum Resources Development Act. After the ANC moved to government in 1994 he was a founder member of the policy think tank, the Minerals
and Energy Policy Centre (MEPC) where he headed the Minerals Policy team.

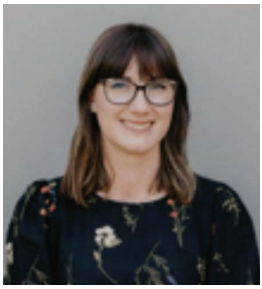
In South Africa he has served on several governmental and inter-governmental bodies in South Africa and elsewhere. He was the mining expert on the South African Ministerial Water Advisory Committee, the Geosciences Council Advisory Committee, the National Survey Advisory Council and on a number of Judicial and Ministerial Commissions of Enquiry including the mining of mineral sands in environmentally sensitive areas at Richards Bay and around the St Lucia Reserve, the location of the then Iscor Steel Plant at Saldanha Bay, the storage of Iranian Oil at the CEF bunkers at Saldanha Bay and the storage of imported nuclear waste at the Vaalputs Radioactive Waste Disposal Facility in the Northern Cape. He was also a member of a review panel for the South African Presidential Commission for revitalising the South African Mining Industry, Phakisa. He is a member of the Agricultural Economists Association of South Africa ("AESA") and served on the Steering Committee for the formation of the South African Agricultural Development Agency ("AGDA") where he chaired the Policy Committee. For the last three years he has been the Senior Advisor to the Council for Geoscience and Department of Minerals and Energy on the National Mine Closure Strategy. He has served on the Board of the United Nations Global Compact in South Africa and is currently a Non-Executive Director of the Federation for a Sustainable Environment.

On international platforms Prof Solomon has served as the UNDP Expert Advisor on the Role of Mining in Poverty Alleviation in Tanzania in 1995 and on the United Nations Economic Commission for Africa (UNECA) Expert Group on Minerals Beneficiation from 2015-2017. In 2015 he served as an expert advisor to the UNECA High Level Dialogue on Accelerating the Rwandan Economy under the auspices of the Rwandan Presidency. He served on the Global Agenda Council for the Future of Mining and Metals of the World Economic Forum from the inception of the Council in 2008 to its dissolution in 2016 and remains a member of the WEF Global Expert Network.

Importantly, Prof Solomon has retained his industry roots as a miner, mine manager and mining engineer. He has served as an Independent Non-Executive Director on the Board of ASX-listed Gold One (the precursor company for Sibanye-Stillwater) where he chaired both the Audit and risk and the Technical Committees. He was Chief Executive of Wesizwe Platinum where took the company from first borehole through listing on the JSE and the raising of full funding for the capital construction of the Bakubung Platinum Mine, which is now in production. He currently serves on the board of Sedibelo Resources Limited, a mid-tier Platinum producer for whom he Chairs the Board Technical Committee and sits on the ESG Committee.

He is the founder and Chief Executive of Carbon Neutral Energy Systems (CNES), a company specialising in systems integration in carbon neutrality programmes for mines. He has served as a Member of Council of the of the Southern African Institute of Mining and Metallurgy (SAIMM) for over a decade and he chairs the SAIMM ESGS Committee. In 2022 Prof Solomon was awarded an Honorary Life Fellowship of the SAIMM for his contribution to mining in South Africa. He is an Incoming Vice-President of the SAIMM.

He is an Adjunct Professor in the Department of Chemical Engineering at the University of Cape Town where he specialises in the economic diversification and decarbonisation of mines. He is also an Adjunct Professor in the Department of Natural Sciences and Agriculture at the University of the Free State where he is Chairman of the Centre for Mineral Biogeochemistry works on the cultivation of various forms of biomass as energy feedstocks for the production of carbon neutral energy carriers for mines. Notably, Prof Solomon is the chief architect and strategist, convenor and Senior Advisor to His Majesty King Letsie III of Lesotho's Just Energy Transition Fund which has been set up to replace the country's economic dependence on the remission of mineworkers' wages with a sustainable economy premised on the sale of green energy to the South African mining sector. He is also a Senior Advisor to Kgosi Leruo Molotlegi of the Royal Bafokeng Nation on a Post-Mining Economic Strategy for the Royal Bafokeng Nation.



Tanisha Schultz

Senior Analyst, Project Blue

Tanisha is a Senior Research Analyst at Project Blue, covering the manganese and chromium markets. She leads the stainless steel team and manages ferroalloy research in South Africa, where she has conducted extensive research into regional production dynamics.

Tanisha's expertise spans market analysis, production and cost modeling, and geopolitical risk assessment. She monitors developments from upstream mining through refining and logistics to end-use demand, particularly in sectors linked to the energy transition and advanced materials. She brings valuable insight into how global energy and trade shifts—such as rising electricity costs, carbon regulation, and shifting export policies—are reshaping cost structures and competitive positioning through the ferroalloys supply chain.

In addition, Tanisha contributes to research on CO_2 emissions and sustainability in extractive and refining industries, building on her academic background in geosciences.

Platinum's strategic positioning and economic importance in South Africa

A.A. Mkonde, I.P. Dikgwatlhe
University of South Africa, South Africa

South Africa's strategic importance in the global platinum market is further underscored by the government's declaration of platinum as a strategic mineral. This policy decision, coupled with the nation's significant share of the world's production and reserves, and its production of 70-80% of the world's platinum supply, solidifies its leading position in the industry.

Platinum's economic impact is profound, influencing industrialisation, investment, and the advancement of alternative technologies. Its use in various sectors, from jewellery, automotive to renewable energy, drives demand. However, factors such as political instability, price fluctuations, water, electricity, infrastructure and electric vehicles pose risks to its strategic status.

The paper aims to develop a model to position platinum and enhance its economic importance strategically. Analyses of data patterns, economic effects, mining output reserves and resources, operational efficiencies, policy framework effects, and SWOT and PESTEL were considered. Key findings include critical importance to high-tech industries, resource endowment, economic and energy security, international and national interests, socio- economic contribution to GDP, exports, employment, industrial and technological inputs, taxes and foreign investment, which lead to strategic importance and positioning.

The framework promotes and positions platinum as a strategic mineral in South Africa. Some parameters of the model are strategic and economic drivers, international collaboration, private partnerships, educational awareness, employee upskilling, research initiatives into new applications and utilisation of platinum. The model ensures that all stakeholders strategically position platinum and enhance its economic importance, including equal benefit- sharing in all sectors of the economy.

Keywords: Platinum, strategic mineral, economic importance, energy

Amanda Akhona Mkonde
Junior Lecturer
University of South Africa

Ms Akhona Mkonde is a Geologist by profession with experience in academic and scientific research. She started her career as an intern for South African National Biodiversity Institution and moved to the University of South Africa as a Technical Officer working in the Mining Engineering Laboratory. She has upgraded and developed Mining Engineering Laboratory at UNISA from a classroom state to a laboratory. She has also been involved in several Water Research Commission and National Research Foundation funded projects.

People: The critical link in realising value from a digital solution implementation

G. Lane
Vuuma Collaborations, South Africa

Despite the abundance of digital solutions available to the mining industry, many implementations have failed to deliver their promised value. A key reason lies in insufficient attention to redesigning the operating model to align with the new ways of working that digital technologies demand.

This paper presents a case study from a multinational mining company that invested significantly in a Manufacturing Execution System and Power BI dashboards for real-time operational monitoring by the management team. After two years of use, this digital solution failed to yield any measurable performance improvement.

The breakthrough came from adopting a people-centric approach focused on co-creating a fit-for-purpose work management process with frontline operators. Through onsite engagement, value stream mapping, TAKT analysis, and constraint identification, the team developed a system-level understanding of performance potential. Value driver trees were used as a methodology to assist operators to identify leading indicators that they could influence directly.

A structured work management process was designed with operations leadership to control these leading indicators through a weekly cycle of work validation, planning, integrated scheduling, tactical resourcing and execution. This ensured alignment across engineering maintenance and production shift planning to meet forecasted demand. A focus on the constraint was an important aspect of planning as it ensured that resourcing and efforts were prioritised appropriately to achieve value stream performance. Realtime Power BI reports were deployed on the shop floor, focusing only on actionable leading indicators impacting performance. Control charts were deployed for the team leads and shift supervisor to identify and address special cause variation impacting performance as part of their weekly performance review. Capability histograms were introduced for the production manager to monitor performance relative to targets.

The result was a substantial and sustained performance improvement maintained over the past 11 months, demonstrating the critical role of operating model integration in realising the full value of digital investments.

Gary Lane

Vuuma

With a passion for transforming the mining industry, Gary Lane has established a global reputation as an industry leader and innovator over the past three decades.

Gary's distinguished career began with Anglo American, where he held various engineering and project management roles, successfully delivering multiple mega capital projects. After completing his MBA, he co-founded Cyest Corporation 23 years ago, a pioneering consultancy focused on mining optimisation that helped reshape industry approaches to operational excellence.

His entrepreneurial vision led to the launch of a technology startup dedicated to next-generation mining solutions, followed by the establishment of the Vuuma Group of companies eight years ago. The Vuuma Group specialises in accelerated adult learning and people-centric consulting with an emphasis on systems thinking—addressing the critical human element often overlooked in technical industries.The Vuuma Group specialises in accelerated adult learning and people-centric consulting with an emphasis on systems thinking—addressing the critical human element often overlooked in technical industries.

Gary is a Fellow of the SAIMM and served as the Chairperson of the SAIMM Technical Programmes for the past 7 years.

Repositioning community development as strategic capital in the PGM value chain

L.N. Ntanzi
Gerson Lehrman Group, South Africa

As the platinum group metals (PGM) industry navigates growing scrutiny over environmental, social and governance (ESG) performance and stakeholder expectations, community development is emerging as more than just a corporate social responsibility obligation — it is a strategic lever for competitiveness, relevance, and long-term resilience.

This paper builds on qualitative insights and MBA research conducted in South Africa's platinum belt to explore how mining firms can reposition community development as a driver of stakeholder trust, operational stability, and shared value. Using a case-informed framework, the study demonstrates how socially attuned stakeholder strategies can reduce risk exposure, enhance social licence to operate, and contribute to cost management through reduced community-related disruptions.
Key findings highlight the need for integrated planning that embeds social investment into operational and supply chain decision-making, rather than treating it as a parallel or reactive function. The paper proposes a practical framework for aligning community development initiatives with core business objectives, informed by current ESG reporting practices, local policy shifts, and community engagement challenges in the South African context.

By linking community development to competitiveness and relevance, this contribution aims to reframe social performance as a strategic asset — and spark dialogue on self-determined development pathways that position the PGM sector for a resilient, inclusive future.

Keywords: Community development, stakeholder strategy, ESG, platinum mining, social licence, competitiveness, shared value, South Africa

Lunga Nkosana Ntanzi

Subject Matter Expert – Mining & Processing
Gerson Lehrman Group affiliated, independently consulting

Lunga Ntanzi is a Mining and Metallurgical Operations Leader with over a decade of experience improving concentrator, smelting, and refining performance across the platinum group metals (PGM) value chain. His career blends deep technical expertise, operational leadership, and strategic vision, underpinned by a strong commitment to safety, discipline, and sustainable value creation.

Lunga began his professional journey at Anglo American Platinum, where he rose through progressively senior roles — from Metallurgist to Senior Metallurgist, and later serving as Acting Technical Superintendent and Acting Production Superintendent. In these leadership capacities, he managed multidisciplinary teams responsible for plant stability, process optimization, and metallurgical efficiency.

His initiatives improved recovery performance, reduced energy consumption, and strengthened process control across hydrometallurgical and pyrometallurgical operations. Lunga also played a key role in implementing Process Safety Management (PSM) systems and enhancing operational risk frameworks to align with the Mine Health and Safety Act (MHSA). Known for his structured, data-driven approach, he consistently bridged the gap between technical excellence and production accountability, driving measurable improvements in plant reliability and output quality.

As a Subject Matter Expert with GLG Consulting, Lunga extends his expertise to global mining clients, investors, and analysts seeking insights into mineral processing, plant optimization, and strategic investment decisions. His consulting work spans grinding media performance, energy efficiency, automation, and commodity market dynamics across platinum, gold, copper, and iron sectors. This global exposure has broadened his perspective on how operational discipline and financial insight combine to drive sustainable competitiveness in the mining industry.

Lunga holds a Bachelor of Science in Chemical Engineering and a Master of Business Administration (MBA) with Distinction in research from the University of the Witwatersrand. His MBA research, "Community Development as a Stakeholder Management Strategy in the South African Platinum Mining Industry," earned recognition for its relevance to sustainable mining leadership and stakeholder engagement.

He has also completed advanced metallurgical programs in hydrometallurgy, pyrometallurgy, flotation, and comminution, as well as certifications in Process Safety Management and MHSA 2.6.1 Legal Accountability. These qualifications complement his technical depth with business acumen and governance awareness, positioning him to lead complex operational and strategic initiatives.

Lunga's leadership philosophy centers on excellence through people, process, and purpose. He believes that strong results flow from disciplined systems, empowered teams, and clear strategic intent. With a reputation for calm authority and analytical precision, he is known for turning technical insight into actionable operational strategies that deliver tangible financial and productivity gains. In addition to his technical and strategic consulting work, Lunga has developed a proprietary framework for repositioning community development as strategic capital in the PGM value chain. This framework is independently authored and licensed by Lunga Ntanzi, and is available for strategic advisory, rollout, and partnership use, it is not affiliated with or owned by GLG.

Today, Lunga continues to contribute to the mining and metals industry through consulting, research, and leadership development. His long-term vision is to help shape modern mining organizations that are technically advanced, socially responsible, and globally competitive — operations that balance profitability with community impact and sustainable innovation.

The use of ultrasonic atomisation methods to produce PGM and alloy powder for 3D printing at Mintek

D. Mkhonto, K. Dyal Ukabhai, L. Mampuru, R. Diale, M.J. Phasha, S.J. Moema
Mintek, South Africa

Additive manufacturing is a growing industry and there is need for new methods to produce spherical powders with a specific particle size distribution suitable for 3D printing in South Africa. While platinum group metals (PGMs) are important minerals in various applications including jewellery, intricate designs from their alloys that may be malleable could be difficult to achieve. This is where additive manufacturing and metal 3D printing in particular become crucial. It is thus necessary that better and more efficient methods for atomisation are implemented in order to produce suitable powder that also add value to PGMs produced in the country. Powders used in 3D printing are mainly imported and there are a times limited alloys available, leading to in-situ 3D printing. In this paper, we present powder production results from an ultrasonic atomisation method using the Amazemet rePowder machine. Recycled Ti-Al powder, 304L stainless steel wire and pure platinum were successfully atomised into spherical and narrow particle size distribution (PSD) suitable for laser powder bed fusion (LPBF) 3D printers and for sintering technologies. More than 80% of produced powders were found to be spherical and the compositions resulted as expected for the alloy material in 304L steel wire. The methods produced Ti-Al powder with PSD of d50 = 45 µm, 304L steel wire powder with PSD of d50 = 50 µm and for pure platinum, d50 = 35 µm. The platinum powder was tested for 3D printing and found to be flowing and produced continuous single tracks without satellites and good density. The results show that used metal powders can be recycled into useful powder in additive manufacturing; pre-alloyed metals, in this case 304L steel wire, can be produced into alloyed spherical powder and PGM materials. In this paper pure platinum as an example can be atomised to spherical powder, and all the produced powders are within PSD that is suitable for LPBF printers and sintering technologies.

Keywords: Ultrasonic atomisation, metal 3D printing, particle size distribution, particle shape, platinum group metals, jewellery, powder metallurgy

Donald Mkhonto

Principal Scientist
Mintek

Donald Mkhonto is a principal scientist researcher at Mintek with over 25 years of experience in the field of materials science and physics. Having obtained his PhD in computational materials science more than 20 years ago, his previous work and contribution has been disseminated in many conference presentations over the years and published in several peer reviewed journal articles. Donald has worked for different institutions internationally like the Crystallography department at Birkbeck College University of London-UK and geology-geochemistry department at University of Wisconsin in the United States of America. Locally, prior to joining Mintek, Donald Mkhonto worked for institutions like the University of Limpopo (UL), Council for Scientific and Industrial Research (CSIR), Tshwane University of Technology (TuT), and the UK based Johnson Matthey PLC. His scientific contribution in the field was on atomistic simulation methods and interatomic potentials development mainly applied on oxide materials surfaces and surface interaction with organic adsorbents. This work is extensively demonstrated in several publications on biomaterials for implant applications as well as geological understanding of carbonate materials found in mars. He has also worked on classified work in catalysis and metal surface tarnishing at Johnson Matthey. In addition to his teaching experience at various academic institutions, Donald is currently heavily invested at Mintek Advanced materials division where he is responsible for research and development of materials aimed towards additive manufacturing technology development in the country. Leading a team in additive manufacturing and alloying of systems, he has contributed immensely to several publications of metal alloys and alloying procedures using state of the art systems under highly controlled inert environment at Mintek and has also worked on several metal powder production suitable for metal 3D printing, tested, and continues to do so.

Powder production of pre-alloyed Platinum alloys for jewellery applications

K.D. Ukabhai, D. Mkhonto, L. Mampuru, R. Diale, M.J. Phasha, S.J. Moema
Mintek, South Africa

The advancements in additive manufacturing have created a new interest in platinum (Pt) jewellery alloys. There is interest in Pt as it is difficult to cast intricate patterns, but these can be done by additive manufacturing. Platinum powder is imported and there are limited alloys available. It is produced by gas or water atomisation which has its drawbacks due to moisture content and particles not being spherical. Ultrasonic atomisation uses vibrations to create powder from molten metal. It is known to produce clean spherical powders that are ideal for laser powder bed fusion printing. For this paper a known jewellery alloy Pt-5Cu (wt%) and studied at Mintek; Pt-2.5Ag2.5Au (wt%) was used to make powder by ultrasonic atomisation on the Amazemet rePowder machine. The powder was analysed for suitability to use in 3D printing and characterised to determine if particles were alloyed. It was found that Pt-5Cu (wt%) alloyed well and had particles within the size range. The Pt-2.5Ag2.5Au (wt%) powder did alloy but did not have the correct composition and had some non-spherical particles, therefore process optimisation is needed for this alloy. The machine does produce spherical powder that is suitable for laser powder bed fusion printing.

Keywords: Ultrasonic atomisation, additive manufacturing, platinum group metals, jewellery, powder metallurgy

Kiyaasha Dyal Ukabhai
Engineer
Mintek

Kiyaasha Dyal Ukabhai obtained her PhD in Metallurgy and Materials Engineering at the University of the Witwatersrand in 2023. She then worked for a short period as an intern before becoming an engineer at Mintek in the Advanced Materials Division in the physical metallurgy group. She has experience in alloy development, corrosion studies and failure investigations. She is also part of the additive manufacturing team which focuses on producing powder for laser powder bed fusion 3D printing purposes.

Complex transformative and adaptive systems in a rapidly changing mining Industry

M. Solomon
Mintek, South Africa

The global mining sector is rapidly undergoing unprecedented multi-dimensional change that is fundamental in driving the structural and systemic transformation of the sector. This is particularly true of the platinum sector which, over the last two decades has navigated several market storms and witnessed as many sea changes in the platinum group metals market. Demand for minerals from the industrial, defence and consumer sectors as well as for instruments of value and wealth has driven mankind's economy since the onset of the iron age. Progressive changes in the technology of mining and beneficiation have defined the progress of civilization and with it, geopolitics and conflict. The winning and sale of minerals was historically and remains the primary transactional economy that has spawned every other form of economy since time immemorial. The expanding social need and ability of mankind to productise metals into an infinite variety of forms and uses ultimately defines consumer demand which drives the manufacturing sector. This in turn directs and fuels mining in every respect. Since the onset of the industrial revolution, the suites of metals mined and their cyclical behaviour has essentially remained relatively constant with increasingly sophisticated uses. However, recently exponential changes in almost all technologies have fundamentally altered commodity demand for new mineral uses, volumes in 'traditional' minerals, the value of mineral commodities across the board and has distorted conventional commodity cyclicity. These multidimensional changes are founded on:

- Population growth, urbanisation and rising standards of living in emerging economies;
- The Global Energy Transition and the quest to mitigate climate change by 2050;
- Recycling and cleaner technologies;
- Social licence and just transition;
- Automation, digitisation and mechanisation of work;
- Artificial intelligence and IoT;
- Resource nationalism;
- The rapidly changing nature of economy, conflict and war; and
- Geopolitical tension around the sourcing of a diverse range critical minerals that underpin the advanced complex technologies in nano-chips and battery applications and durability.

This keynote address frames how these dynamics are reshaping the future of work, the forces of commodity demand, the trajectories of geopolitics, the nature of social economy and the structure of our environment. The management of these multi-dimensional factors that are redefining the mining sector is highly complex. It explores these factors through the lens of mining risk and resilience. It seeks to simplify the complexity of this landscape by reducing risk into four common pathways describing:

- Transactional risk;
- Socio-economic risk;
- Environmental risk; and
- Political economic risk.

The complexity lies in determining the functional and economic algorithmic relationships between each of these individual risk elements. As in any risk assessment, each risk relationship is expressed in financial and economic terms and is reduced to a cost benefit of their respective mitigatory interventions. Given the speed with which changes in the sector are taking place and the sheer number of intersecting factors, risk needs to be constantly reassessed and re-evaluated in real time to enable mining operations the agility to adapt timeously and to survive radical change, hence the term 'Complex Adaptive and Transformative Systems' and 'Mining Risk and Resilience'. This highly integrated multi-dimensional systems-based approach to systemic risk must by necessity be data- driven, understandable to and implementable by pragmatic miners. It is by no means an academic concept or a 'black-box' methodology. This field is an evolution of existing risk analysis and an essential tool in mining strategy and operational flexibility.

An exploration of the working conditions of women employed in mining operations at a platinum mine in South Africa

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Orientation: The mining industry in South Africa has historically been dominated by men, with both legislative and structural barriers restricting women's participation. However, over the past three decades, various legislative frameworks, including the Employment Equity Act of 1998, the Mine Health and Safety Act of 1996, the Mineral and Petroleum Resources Development Act of 2002 and the Mining Charters of 2004, 2010 and 2018, have progressively facilitated women's inclusion in the industry. Despite a notable increase in women's participation, the mining industry remains a challenging environment for women, who continue to face multiple obstacles. These challenges are frequently cited as factors contributing to the attrition of women from the industry and as reasons why mining companies struggle to achieve the targets set by the Mining Charter.

Research Purpose: This study investigated the working conditions of women employed in mining operations at a platinum mine in South Africa.

Motivation for the Study: The study was driven by the need to investigate the conditions that hinder women's full participation in the mining industry.

Research Approach/Design and Method: A quantitative approach was adopted, underpinned by an objectivist ontology, an empiricist epistemology, and a positivist research paradigm. Data were collected through a questionnaire survey and analysed using exploratory factor analysis, and descriptive and inferential statistical methods.

Main Findings: The data yielded significant insights regarding respondents' working conditions at the mining company in relation to company policies and benefits, development opportunities, infrastructure facilities, physical proficiency abilities, health and safety considerations, and workplace practices. Although the mining company provided benefits like housing, medical aid, pensions, and maternity leave, deficiencies persisted in travel allowances and childcare support. The study identified poorly-communicated gender-sensitive policies and limited opportunities for women's career advancement. While health and safety measures were sufficient, the lack of gender-sensitive protective equipment and maternity accommodation posed challenges. Additionally, gender-based discrimination, workplace harassment, and structural barriers contributed to high attrition rates among female employees.

Contribution/Value-Add to Conference: The study contributes to the 9th International PGM Conference by examining sustainability and social performance within the platinum mining sector. While the industry predominantly emphasises technological innovation, this research focuses on the working conditions and challenges encountered by women in platinum group metal (PGM) operations. By exploring barriers such as gender discrimination, limited career advancement opportunities, inadequate policies, and deficiencies in health and safety provisions, the study offers evidence to enhance inclusivity and workforce retention. These findings resonate with the conference themes of self-determination, relevance, and competitiveness, highlighting the importance of a diverse workforce for industry sustainability. The identification of shortcomings in protective equipment, maternity accommodations, and support structures provides insights for improving workplace policies and reducing attrition. This aligns with safety and cost management themes, as addressing these issues promotes employee well-being while minimising turnover costs. By linking gender inclusion to operational excellence, the study demonstrates how social performance intersects with technological advancements, offering recommendations for mining companies and stakeholders dedicated to fostering a socially responsible PGM sector.

Keyword: Mining charter, mining industry, mining operations, South Africa, women, working conditions

The Implats Group's decarbonisation strategy

T. Mthombeni
Implats, South Africa

Impala Platinum Holdings Limited (Implats), a leading platinum group metals producer, is actively implementing a comprehensive decarbonisation strategy, which reflects its commitment to responsible metals production and its intention to create a better future. The Group seeks to achieve carbon neutrality by 2050, with a short-term target to reduce carbon emissions 30% by 2030, against 2019 as a baseline year. This strategy is in effect across its operations in Zimbabwe, South Africa and Canada. Key focus areas of the Group's decarbonisation strategy include strengthening the security of electricity supply and reducing greenhouse gas (GHG) emissions and long-term input costs by integrating renewable electricity into its electricity supply options. The energy activities include site-based projects and strategic contracts to deliver renewable energy at its operations, shifting the Group's grid electricity supply to renewable electricity.

By the end of FY2024, total renewable electricity accounted for 37% of the Group's total electricity consumption (FY2023: 30%), with market instruments accounting for 53% of its renewable electricity mix. This marked a historic cross-over point for Implats.

A pipeline of renewable energy projects

- Implats has completed construction and commissioning of a US$37 million, 35 MW solar photovoltaic plant at its Zimplats operation, the first of such scale in the Group and the first and largest utility scale solar power plant in Zimbabwe.
- The second phase at Zimplats, a 45 MW solar project, has been approved by the board and once completed will generate about 103 000 MWh of green electricity and reduce our carbon emissions by some 64 000tCO_2e per year.
- In January 2025, Implats signed a five-year renewable energy supply agreement with Discovery Green to supply wheeled renewable electricity to its Impala Refineries operation, based in Springs, east of Johannesburg, which will significantly reduce Impala Refineries' Scope 2 GHG emissions — by more than 852 000 tonnes CO2e over the initial five-year period of the contract.
- At Impala Rustenburg in the North West province, we completed a bankable feasibility study for a 140 MW solar project which will generate some 9% (319 000 MWh) of the site's electricity needs and reduce our carbon emissions by approximately 344 000tCO_2e per year.
- At our Marula operation in Limpopo, we have completed a bankable feasibility study for a 30 MW solar project at the site, which will generate some 30% (70 000 MWh) of green electricity and reduce our carbon emissions by approximately 74 000tCO_2e per year.
- The Group has already implemented several rooftop solar solutions (<1 MW) at its South African operations.
- Our energy and decarbonisation policy commits the Group to at least a 30% renewable energy mix for all new mines.

Implats aims to reduce absolute carbon emissions by 1.7 million tonnes CO_2e by 2030 and is targeting 60% renewable electricity consumption by 2030. The Group's decarbonisation strategy is a climate imperative and a catalyst for innovation, inclusive development and long-term value creation. Implats has positioned itself as a leader in sustainable metals production.

Dr Tsakani Mthombeni

Executive: Sustainable Development at Implats
Implats (Impala Platinum Holdings Limited)

Dr Tsakani Mthombeni is Executive: Sustainable Development at Implats, a PGMs mining company based in South Africa with operations in Zimbabwe, South Africa and Canada, where he is responsible for developing and implementing the Group's Sustainable Development strategy. Prior to this role he was Vice President: Group Head of Carbon and Energy at Gold Fields, leading Gold Fields's energy management and climate change strategy and supporting its execution across eight (8) gold mining operations in four (4) countries – South Africa, Ghana, Australia and Peru. Prior to this role, Dr Mthombeni spent five (5) years sourcing and funding pre-commercial new energy technologies in South Africa as the General Manager: Energy, at the Technology Innovation Agency. Mthombeni was also with Anglo American as group Senior Energy Engineer, developing standards and guidelines for energy management initiatives across the diamonds, platinum, coal, iron ore and platinum assets. Mthombeni also worked at South Africa's power utility, Eskom as a technical specialist, following a research officer stint at the University of Cape Town. Dr Mthombeni studied BSc at the University of Cape Town (South Africa), then Clarkson University, Potsdam, New York, USA for MSc and PhD, both in electrical engineering. He serves as an external examiner at the University of Pretoria, Cape Town and Stellenbosch University. He was the current Chair of the Energy Intensive Users Group (EIUG) of South Africa, whose membership contributes just over 20% to the GDP and employs nearly 700 000 people in South Africa. He also served on the Presidential Task Team on Eskom Sustainability (under President Ramaphosa, 2018/2019) and was a co-ordinator of the Eskom Ministerial Technical Review Team (under Minister Pravin Gordhan, 2019). An avid runner who completed five iconic Comrades marathons (annual 90 km single day road running race in South Africa).

Decarbonising the Platinum Group Metals value chain to lower the carbon footprint of energy transition technologies

D. van Wyk, S. Thakurdin
Hatch, South Africa

Platinum group metals (PGMs) are a key material required for the energy transition, with widespread use in several clean technologies' production process. Due to the various processing steps included in PGM production, a full value chain overview was conducted to identify the biggest sources of emissions and develop potential abatement strategies. The PGM value chain has a large carbon footprint due to the high energy requirement across each process step. A large portion of emissions stem from electricity usage across the value chain, due to the South African grid's reliance on coal for electricity generation. There are additional emission sources which includes the use of fossil fuels for powering mining vehicles and machinery, the use of reductants, as well as chemical reagents. The largest emission area in the value chain is at the refining processes; however, this is on an intensity PGM basis. Due to the refining process treating a smaller volume quantity than the upstream areas, on an absolute emission basis this is where the largest emissions stem. Various technologies are available to decarbonise the PGM industry. Abatement opportunities vary from commercially ready, such as deploying electric vehicles, to viable, but supply chain constraints exist such as the case for biofuels, and to ones where technology is demonstrated but not industrially deployed, such as biocarbon reductants. Given the current fluctuating PGM market, lack of policy pressure and government funding opportunities, it is not an ideal environment to implement operational decarbonise measures. However, as countries globally are introducing more stringent carbon legislation such as carbon taxes, as well as taxing imported carbon, the industry risks falling behind and becoming more exposed to carbon prices in the long term. Technologies such as wind turbines and electrolysers which produce green hydrogen are key decarbonisation options for global industry and are produced using PGMs. Although technologies may be called "clean" or "green" they still result in negative environmental impacts if the upstream emissions from input materials are carbon intensive. Therefore, for these energy transition technologies to truly enable a cleaner world, the input PGM material needs to decarbonise to ensure entire lifecycle emissions are reduced.

Dian van Wyk
Junior Engineer
Company: Hatch

Dian graduated from the North-West University with a bachelor's degree in chemical engineering. Upon graduating, he joined Hatch as a junior process engineer in the Climate Change Business Practice. During his time at Hatch, he has worked on decarbonisation projects for various mining-, mineral processing-, hydrometallurgy-, energy- and port-operations across the world. His focus area is on preparing decarbonization strategies for clients which includes greenhouse gas emissions profiling, opportunity identification and quantification, and decarbonization pathway development. Dian's project experience includes climate change adaptation analysis and risk identification and mitigation. Dian is knowledgeable on global climate change standards, regulations, and carbon credits. His knowledge of carbon regulations includes reporting standards and carbon tax obligations for various global regions to incorporate these levers into a company's decarbonisation strategy.

Implementation of high frequency power supplies and dual flue gas conditioning in particulate matter abatement in the PGM industry

B.P. Havenga[1], E. Eichler[2], H. Heller[3]

[1]Impala Platinum, South Africa
[2]Fuel Tech, Inc., United States of America
[3]Lesedi Nuclear Services, South Africa

Industrial processing plants are managed and assessed through various key performance indicators, involving personnel safety, throughput, engineering availabilities, operating factors and legal compliance aspects. Over the course of equipment lifespan, changes in feed material, staff experience and maturity levels of available technology often necessitate adapting control philosophies to meet production targets within the applicable environmental guidelines and legislative requirements.

In order to maintain and ensure continued compliance to Minimum Emission Standards related to particulate matter point source emissions from the Niro spray drying operations at Impala Platinum's Rustenburg smelter operations, relevant primary abatement equipment had to be upgraded. Electrostatic precipitation systems (ESPs) are employed to recover particulates from the spray dryer flue gas outlet streams. The selected upgrade comprises replacement of low voltage transformer rectifier sets with High Frequency Power Supplies, as well as implementation of Dual Flue Gas Conditioning, to improve collection efficiencies of the existing ESPs.

Bennie Havenga

Process Specialist: Smelting
Impala Platinum Holdings (Pty) Ltd

Bennie holds a Chemical Engineering degree from North-West University, obtained in 2008, whereafter he started his career as a Metallurgist at Impala Platinum. He presently serves as Process Specialist: Smelting within Impala Platinum's Processing Projects department. Bennie has over 15 years' experience in the PGM smelting industry, fulfilling a combination of technical support and project-related roles.

Zimplats SO_2 abatement plant design

S. Matutu[1], J. Bezuidenhout[2], G. Erasmus[2]
[1]Zimplats, Zimbabwe
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The 2024 expansion at the Zimplats Selous Metallurgical Complex (SMC) included the installation of a new 38 MW electric smelting furnace and two 12x24 Peirce-Smith converters. This expansion introduced new primary off-gas sources requiring off-gas cleaning and SO_2 abatement.

The design of the primary off-gas system starts with understanding the upstream smelting process conditions and flow variability that influence the off-gas system's operation. Once the process conditions are defined, selecting the SO_2 abatement technology involves evaluating various options and screening them against project-specific criteria. This initial engineering phase provides the basis for further process engineering, flowsheet development and disciplined engineering. These design steps are discussed as well as detail engineering considerations such as key process controls and mechanical layout development.

Keyword: Zimplats, Smelter Gas Cleaning, Sulphuric Acid, SO_2 Abatement, Platinum Group Metals (PGMs), WSA Plant, Electric Smelting Furnace, Peirce Smith Converting

Johan Bezuidenhout
Snr. Process Engineer
Hatch

Johan is a Registered Professional Process Engineer with 17 years' experience in the metallurgical industry.

Johan has an engineering degree in chemical engineering and a master's degree in metallurgical engineering from Stellenbosch University and a master's degree in engineering management from the University of Pretoria.

Currently, Johan is part of the Industrial Clean Technology Group within Hatch with the focus on developing waste gas solutions across all commodities.

Innovative solutions for SO_2 abatement: The role of the WSA process in the PGM industry

C. Frandsen
TOPSOE A/S, Denmark

The platinum group metals (PGM) industry faces increasing pressure to reduce SO_2 emissions. While treating strong SO_2 gases is standard, handling lean and fluctuating SO_2 off-gases is a future challenge. These gases, which can have both low SO_2 concentrations and be highly fluctuating, present both operational challenges and opportunities. This paper explores the sources of these gases from furnaces and smelters and specific obstacles that may arise when these are to be handled. The paper focuses on efficient methods for dealing with sulfurous off-gases and examines innovative solutions like the wet gas sulfuric acid (WSA) process to enhance sulfur abatement, energy efficiency, and regulatory compliance.

As regulatory authorities tighten emissions standards for the metallurgically industry—such as the stringent SO_2 emission requirements implemented in South Africa recently — there is increasing pressure to improve SO_2 capture across plant operations while maintaining both sulfur recovery and energy efficiency. The drive to reduce greenhouse gas emissions and increase circularity further emphasises the need for innovative solutions to SO_2 control.

In the typical off-gas from the furnaces and smelters there is a wide range of off-gases containing varying amounts of SO_2, with concentrations ranging from low level to several percentage points. High-concentration SO_2 gases are routed to gas cleaning systems and sulfuric acid production units to minimise emissions and recover sulfur. However, lower concentration SO_2 gases are either released into the atmosphere or treated with scrubbers.

Using a scrubber to handle large volumes of low-concentration SO_2 is perhaps the simplest solution, given the lower number of equipment required. However, this leads to sulfur being captured in a by-product of lower value compared to commercial-grade sulfuric acid. Additionally, the chemicals used in this process add significant operating costs, as does the transportation of chemicals and by-products, further complicating the operation.

The WSA process represents a viable solution, allowing plant operators to recover sulfur from leaner gas streams while maintaining high energy efficiency and reducing the need for additional chemicals or external energy input. This approach not only enhances plant performance but also supports the PGM industry's long-term sustainability goals.

Casper Vittrup Frandsen

Account Manager
Haldor Topsoe

Casper started his carrier back in 1991 in Haldor Topsoe, where he took up a position as process engineer for Haldor Topsoe's new pilot plant facilities to development Topsoe's technology for different Chemical processes. In 1995 he changed to the Research and development, where he has worked within in many catalyst fields: DeNOx, Automotive, Filtration technology, oxidations catalyst, sulphuric acid catalyst and technologies for the sulphuric acid industry and general new technologies within Haldor Topsoe. In 2008 he changed to the Technical and Sales group where he worked as Senior Technical Advisor for some years before transferring to sales. Today he is Account Manager for the sales and services of Haldor Topsoe Sulphuric acid catalyst business.

Ronnie Madiba

Metallurgical Laboratory Superintendent
AECI Mining Chemicals

Ronnie Madiba is a highly driven leader with over a decade of progressive experience in the mining and chemical sectors. I hold B-Tech in Chemical Engineering and a Postgraduate Diploma in Business Management, combining strong technical expertise with a solid grounding in leadership and strategic thinking. His career reflects dedication, resilience, and an unwavering passion for metallurgy and its complex role in shaping sustainable mineral processing.

Ronnie's professional journey began in 2011 when he joined AECI Mining Chemicals as a metallurgical reagent operator at EPL Lonmin/Sibanye Platinum) mine. Starting at the front end of operations provided him with hands-on exposure to the intricacies of metallurgical processes, particularly reagent application and performance monitoring in mineral recovery. This foundation allowed him to gain deep practical insights into the interaction between chemical engineering principles and real-world mining challenges.

Over the years, Ronnie steadily advanced through the ranks at AECI, assuming roles of increasing responsibility. His progression is a testament to his technical competence, problem-solving skills, and ability to adapt in a dynamic and demanding industry. He developed expertise in metallurgical testing, laboratory supervision, and process optimisation, while also building strong collaborations with mine operations teams to enhance reagent performance and improve recovery outcomes.

Currently serving as Metallurgical Laboratory Superintendent, Ronnie oversees the planning, execution, and reporting of metallurgical test work that supports both clients and internal stakeholders. He plays a central role in evaluating new flotation reagents, improving process efficiencies, and supporting innovation in mineral beneficiation projects.

Outside of his professional commitments, Ronnie is committed to personal growth, mentorship, and knowledge sharing. He takes pride in motivating young professionals entering the field of metallurgy, emphasising perseverance, continuous learning, and integrity as cornerstones of success.

With a career grounded in hard work, technical excellence, and visionary thinking, Ronnie Madiba continues to make a meaningful contribution to the mining and metallurgical industry, positioning himself as a forward-looking leader in the drive toward sustainable mineral processing.

Determination of rhodium from fire assay using lead collection with the addition of co-collector, followed by acid dissolution to enhance recovery and analytical accuracy

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This paper explores the use of co-collectors to enhance the recovery and determination of rhodium (Rh) during fire assay with lead collection, followed by acid dissolution using conventional hot plate methods. Rhodium, a critical platinum group metal (PGM), poses analytical challenges due to its low natural abundance and complex chemistry. Among the co-collectors tested, palladium (Pd) and tellurium (Te) demonstrated significantly improved Rh recoveries, ranging between 100% and 120%, whereas silver (Ag) resulted in poor recovery and higher error margins. These findings highlight that co-collectors can enhance the efficiency and sensitivity of PGM analysis, although their effectiveness is dependent on the chemical interaction with the target element. Acid dissolution was essential to ensure complete digestion of prills prior to analysis, enabling accurate quantification of rhodium. Overall, the findings suggest that palladium and tellurium are effective co-collectors for rhodium determination in fire assay, while silver and lead flux alone are unsuitable. This paper provides important insight into optimising fire assay procedures for reliable rhodium analysis, with potential benefits for PGM recovery and economic evaluation.

Keywords: PGMs, rhodium, co-collector, fire assay, dissolution, recovery

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Tshilidzi Rampfumedzi
Scientist
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Tshilidzi Rampfumedzi is a Scientist in the Analytical Chemistry Division at Mintek, where he specialises in the analysis of Platinum Group Metals (PGMs) and Rare Earth Elements (REEs) using ICP-OES and ICP-MS. He serves as a Technical Signatory in several trace analytical methods and has over five years of experience in elemental analysis and laboratory quality systems. Tshilidzi holds an MSc in Chemistry (cum laude) from the University of the Witwatersrand, where he is currently pursuing a PhD focused on REE determination in coal, coal residues and other REEs bearing minerals. His work aims to support sustainable resource utilisation and innovation in mineral analysis.

Efficient Pt extraction and refining from spent fuel cell catalysts

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Proton Exchange Membrane Fuel Cell (PEMFC) technology has emerged as a promising solution to the global energy challenge due to its high efficiency, zero emissions, and versatility in applications ranging from transportation to stationary power generation. However, the commercial scalability of PEMFCs is hindered by the high cost and limited availability of platinum (Pt), used as the primary electrocatalyst. As PEMFC usage grows, so does the volume of spent fuel cells containing valuable Pt nanoparticles supported on carbon. Recovering Pt from these spent catalysts presents a sustainable alternative to primary extraction and offers significant environmental and economic benefits. In this study, an integrated hydrometallurgical process was developed for the efficient recovery of Pt from spent PEMFC electrocatalysts. Initial test work focused on oxidative leaching in chloride media using hydrochloric acid (HCl) with various oxidants such as H_2O_3, HNO_3, NaClO, and $NaClO_3$. Among these, $NaClO_3$ proved the most effective, enhancing leach efficiency to over 98% under optimised conditions (2.0 M HCl, 3 wt% $NaClO_3$, 90 °C, 120 min). The resulting pregnant leach solution (PLS) containing Pt and trace impurities (e.g., Fe, Ni, Co, Ru) was subjected to purification using solvent extraction (SX). Aliquat-336 and D2EHPA were employed for selective extraction and removal of impurities. A two-stage extraction-stripping sequence enabled the efficient separation of Pt(IV) and Ru(III) from base metals, yielding a highly purified Pt electrolyte. This electrolyte were then screened by IX resins and Pt(IV) were separated from the containing Ru(III). Platinum was subsequently recovered from the purified eluate through precipitation with ammonium chloride in HCl, forming ammonium hexachloroplatinate ($(NH_4)_2PtCl_6$), a reusable catalyst precursor. The most efficient process alternative achieved a Pt recovery rate of 93% with a final product purity of 99.95%, demonstrating a viable, low-impact recycling route for spent PEMFC catalysts and supporting the circular economy in critical metal usage.

Derik van der Westhuizen

Research Scientist

NDerik van der Westhuizen (B.Sc Industrial Science, M.Sc Chemical Engineering) is a specialist in hydrometallurgical separation processes, with over 12 years of research experience focused on solvent extraction (SX) and membrane-based technologies, particularly pertraction (PX). Since 2009, he has played a pivotal role in developing PX for mineral beneficiation applications within the South African metal refinery sector. Derik's work has contributed to proof-of-concept studies across a broad spectrum of metals and resource types, including zirconium, hafnium, platinum group metals (PGMs), uranium, rare earth elements, cobalt, nickel, copper, vanadium, chromium, tantalum, niobium, lithium, manganese, electronic waste, and acid mine drainage. His innovations led to the invention of a PX-based separation method, for which he is the principal inventor on an international patent (WO2012/168915A1), stemming from his PhD research titled Pertraction: An Innovative Technology for the South African Hydrometallurgical Industry.

He has authored 27 peer-reviewed journal articles, contributed to more than 46 national and 13 international conference presentations, and co-authored a chapter in a recognized book series. Derik also leads the project management and technology transfer efforts for PX in South Africa, serving as a key link between industry and academia.

Since 2021, he has headed the Hydrometallurgy Research Group at the two research centres (RFA: CRB and CoE: CbF), overseeing a dynamic team of researchers and students. He currently supervises 3 PhD, 6 M.Sc, 7 M.Eng, 2 B.Sc Honours, and 4 B.Eng students, supported by six research collaborators. At the North-West University's Centre for Sustainable Mining, Derik leads commercial research in Minerals Processing and Refining, advancing sustainable and innovative solutions for the mining industry.

Quantitative spectroscopic analysis of co-existing Platinum Group Metals (PGMs) in iron matrix

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The simultaneous presence of platinum group metals (PGMs) and iron in geological and industrial samples presents analytical problems and opportunities in mineral processing, metallurgy, and recycling. The nickel sulphide (NiS) fire assay collection method provides an efficient pre-concentration procedure, facilitating precise spectroscopic measurement of PGMs in samples containing iron. This research reports a quantitative spectroscopic methodology employing Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), X-ray Fluorescence (XRF), and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for enhanced detection and quantification of Platinum Group Metals (PGMs: Pt, Pd, Rh, Ru, Ir). To enhance analytical precision and accuracy, calibration techniques, matrix interferences, and spectral overlaps were examined. The distinct charge densities, ionic radii, and polarities of iron (Fe) and platinum group metals (PGMs) strongly influence their chemical behavior and geochemical partitioning. Iron forms polar oxides capable of adsorbing trace PGMs, while the more noble and less polar PGMs preferentially concentrate in sulfide phases during magmatic differentiation. Iron commonly coexists with platinum group metals (PGMs) in mafic–ultramafic intrusions due to their shared chalcophile and siderophile behavior during magmatic differentiation. The technique's applicability for geochemical exploration and metallurgical evaluation is demonstrated by the results, which show good recovery rates for Pt, Pd, Rh, Ru and Ir in addition to iron. Despite satisfactory recoveries using ICP-OES, ICP-MS proved to be superior. The study highlights how crucial method optimization is for reliable PGM quantification in complex matrices comprising transition metals like iron in spectroscopic analysis.

Thembakazi Ncedo

Senior Technician
Mintek

Thembakazi is a Senior Technician in the Analytical Chemistry Department at Mintek, where she also serves as an Acting supervisor. With more than 15years of experience in analytical sciences, she has developed strong expertise in laboratory management, method development, and advanced instrumental analysis, including ICP-OES, ICP-MS, XRF, and chromatographic techniques.

In her leadership capacity, Thembakazi provides strategic direction to her department, mentors junior staff, and fosters a culture of accuracy, safety, and innovation. Her role ensures that Mintek's analytical outputs meet the highest standards, supporting critical research and development initiatives in mineral processing and metallurgy.

Academically, she holds a Postgraduate Diploma in Analytical Chemistry and is currently pursuing a Master of Science in Chemistry at the University of the Witwatersrand. Her postgraduate research focuses on the application of analytical techniques to address real-world challenges in materials science and sustainable resource utilization.

Fundamental characterisation of sperrylite leaching behaviour in cyanide systems using XPS

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Sperrylite ($PtAs_2$) is one of the most abundant platinum minerals globally, valued for its economic importance but also known for its highly refractory nature, making it difficult to process via the conventional route. This paper explores the oxidative leaching of sperrylite using a cyanide–ferricyanide system, with a key focus on characterisation of the mineral and surface speciation under varied leaching conditions using X-ray Photoelectron Spectroscopy (XPS). The parameters investigated included the effect of NaCN concentration, the use of $K_3[Fe(CN)_6]$ as an oxidant, $CuSO_4.5H_2O$ as a catalyst, as well as the effects of temperature and particle size. A limited set of leaching tests was carried out to study the surface chemistry rather than optimising dissolution conditions. This approach identified mineral oxidation states and shifts in binding energies, prior to- and post leaching. XPS analysis of sperrylite's surface chemistry identified key species, comprising the bulk Pt(II)–As (≈73 eV) and As(–I)–Pt (≈41.8 eV) states, together with surface oxidation products Pt(II)–O (≈72 eV), Pt(IV)–O (≈74.5 eV), As(III)–O (≈43 eV) and As(V)–O (44.5 eV). Leaching led to the removal of pre-existing oxides on the ultra-finely ground sample, exposing the underlying bulk species. In contrast, the crystalline sample with an initial low concentration of oxides generated higher amounts of fully oxidised species after leaching, reflecting greater surface reactivity.

The full paper will be published in the SAIMM Journal

Kathija Shaik
Research Officer
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Dr. Kathija Shaik is a Research Officer in the Department of Chemical Engineering at the University of Cape Town, affiliated with the Hydrometallurgy Research Group. Her work focuses on sustainable hydrometallurgical processes, with a particular interest on alternative chemistries for metal extraction. During her Master's and PhD studies, she developed expertise in applying electrochemical methods to investigate refractory PGM minerals. More recently, her research has expanded to include metal recovery from secondary sources such as printed circuit boards and lithium-ion batteries, with a focus on purification and separation processes beyond leaching.

Quantification and mineral association of rhodium in low concentration ores using inductively coupled plasma – optical emission spectrometry

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Rising global demand for rhodium (Rh) in the automotive industry contributes immensely to the market's growth and it has been predicted to reach over 1.06 million ounces in 2024. Rh is used largely as a catalyst in the automotive industry. Due to the volatile nature and difficulties in analysing the rhodium together with other platinum group metals from lead-based fire assay collection procedures, Mintek has developed a simple and highly selective method for the determination of Rh from low-grade platinum group metals (PGM) using various co-collectors. The recovered prill was subjected to high-pressure dissolution using tubes and incubated at a mild temperature for 8 hrs followed by instrumental analysis using inductively coupled plasma – optical emission spectrometry. This research focuses on quantification of Rh and mineral association in three major layers of Bushveld complex including Merensky (Western Limb), Upper group 2 (UG2, in the Eastern Limb) and Plaatreef (in the Northern Limb) using fire assay methods, utilising the lead oxide collector, palladium stock. Scanning electron microscope coupled with energy dispersive X-ray and X-ray diffraction indicates the silica dominance, with high silica (SiO_2), iron oxide, and magnesium-bearing chromite for UG2 and Platreef whereas Merensky indicates the anorthite ($CaAl_2Si_2O_8$) mineral dominance. In addition, the particle size analysis exhibit that 90% of particle size 75 µm correspond to homogeneity of the sample. Using fire assay methodology, Rh recovery was determined using certified reference materials from UG2, Merensky, and Platreef and recovery of 90-110% was obtained. Figures of merit such as accuracy, percentage recovery and reproducibility in the range of 95-103%, precision ranging from 5-10% and detection limit of 0.1 mg/L confirmed that the method was fit for purpose. Rh in PGM-bearing ore samples were analysed using a validated method with concentrations determined between 2.5-65 mg/L.

Keywords: Platinum group metals, Fire assay methods, Bushveld complex, Carius tubes, ICP-OES, Rhodium

Comparison of dissolution methods for ICP-OES analysis of PGMs from printed circuit boards

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Despite the adoption of appropriate recycling processes, the increasing volume of electronic waste (printed circuit boards (PCBs)) around the globe may jeopardise the development of new technologies while also having a negative impact on the environment if waste is not properly managed. This is because this waste contains large amounts of valuable metals and harmful materials. Identifying and recovering the precious metallic components from such waste PCB is also critical to meeting market demand given restricted resources. Herein, we compare fire assay and microwave acid digestion methods to recover precious metals using inductively coupled plasma optical emission spectrometry (ICP-OES). A PCB head sample was dismantled physically, crushed, milled and pulverised and 90% of particles passed the 75 µm to maintain homogeneity. Various acids mixture was used including concentrated aqua regia (AR), AR + hydrofluoric acid (HF), AR+ hydrogen peroxide (H_2O_2) and AR+HF+ H_2O_2 all assisted with microwave. ICP-OES indicated the higher PGE recovery for lead fire assay (Pb-FA), ranging (Au =134 ppm, Pd =74.78 ppm, Pt =0.264) as compared to microwave-assisted in various conditions ranging from (Au=117ppm, Pd= 59.5 ppm, Pt= 0.233). Moreover, the results showed high accuracy and recovery percent for the fire assay method and microwave-assisted aqua regia and HF. To conduct contextualisation, in this paper a bibliometric analysis on recent literature between 2001-2025 was conducted, revealing how metal recovery through MW aasisted, hydrometallurgy and pyrometallurgy approach is relevant. The interrelation between keyword map highlights the increasing demand for advanced analytical techniques like ICP-OES, SENM EDX and XRD in ensuring eco-friendly recycling of waste-PCBs within the circular economy. Results indicate the opportunity for recycling and repurposing e-waste, particularly waste-PCBs, will be crucial for both economic and environmental benefits. The incorporation of bibliometric analysis in experimental approach indicated the scientific relevance, methodology justified with global research priorities on PGMs recycling, specifically from e-waste.

Keywords; Recycling, Printed circuit boards, Fire assay, Microwave-assisted acid digestion, ICP-OES , Bibliometric analysis

Two metals, one mine: Unpacking the market dynamics linking chromium and PGMs in a South African context

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Project Blue, South Africa

The chromium and platinum group metals (PGMs) markets are effectively mutually exclusive, with PGMs' role in catalytic applications and investment markets while chromium is primarily underpinned by stainless steel and developments in China. Yet, thanks to the co-mineralisation in the Bushveld Igneous Complex (BIC) and chromium's emergence as a by-product of PGM, mining out of the UG2 has created a structural connection between the two metals.

Understanding the relationship between these commodities starts with examining the cycles in the PGM market: Palladium and platinum have followed very different paths over the past decade, shaped by industrial demand, regulatory changes, and technology. Stricter vehicle emissions standards, for example, pushed catalysts toward greater use of palladium over platinum, reducing platinum demand and reshaping both prices and production strategies. The 2017 PGM price cycle illustrates this dynamic: platinum prices remained weak due to ongoing oversupply and slower auto sales, following the structural shift from diesel to gasoline engines that began around 2015. Meanwhile, palladium continued to strengthen as demand for gasoline vehicle catalysts grew. This divergence shows how quickly regulation, technology, and market conditions can influence the economics of these metals.

With the advent of electric vehicles, the PGM market has entered a phase of uncertainty regarding long-term demand. Declining internal combustion engine vehicles has dampened demand and supply of PGMs and caused a surplus that saw both platinum and palladium prices decline to around the US$1,000/oz mark since 2023. Even geopolitical concerns around supply from Russia have not been able to cause significant short-term supply-demand volatility to prices since the start of the Ukraine war in 2022.

The chromium price cycle has often moved inversely to PGMs. The fundamentals include South Africa as the main mineral supply globally and China being critically reliant on the BIC for over 80% of its concentrate demand. The importance of the UG2 to the chromium industry required development in sintering technology to support the ferrochrome industry, which has ramped up in China with the identification this low-cost, by-product source. As such, PGM producers have increasingly entered the chromium market and becoming part of the top producers globally, such as Sibanye Stillwater (>2.5 Mt per year) and Amplats, now Valterra, (>1 Mt per year) both sitting in the top 10 chromium miners globally. This has meant that a strong chromium market has helped support the mining economics of PGM deposits when platinum prices were weak.

Examining chromium and PGMs through the lens of commodity cycles and broader market drivers provides insight into their interdependent nature. This has seen PGM, and chromium miners alike, assess which resources to target to benefit from by- or co-product credits.

The integrated mine of the future: How five global trends are driving integrated and intelligent mining operations

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Over the next decades, the mining industry is expected to undergo a profound transformation driven by five converging trends: resource constraints, people challenges, a heightened focus on climate change, increased access to data, and the rapid advancement of technology. These forces are reshaping how mines operate and are compelling companies to adopt more deliberate integrated planning and execution strategies. Integrated operations, which brings together people, processes, and technology across the value chain, can be a key enabler in navigating these challenges. This paper explores how these trends are influencing mining operations globally, with examples from recent integrated operations projects, what challenge each project aimed to address, the outcomes and the lessons to be learnt for the future of mining.

Claire Bleazard

AIM Regional Lead – Integrated Operations
Hatch

Claire Bleazard brings 15 years of post-qualification experience as a control and automation engineer focused on digital solutions and integrated operations. Her experience includes projects in mining, mineral processing and oil and gas industries for local and international clients. Claire's roles typically include project management and coordination of globally distributed specialist teams, design and implementation of Integrated Remote Operations Centre projects and developing user and functional requirements.

Claire is a professionally registered engineer and holds degrees in electrical and electronic engineering and a BSc. Honours in Mathematics.

Plasma arc behaviour in DC arc furnace smelting of PGM-bearing materials: A modelling study on the effect of reductant choice

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Aspects of the production of platinum group metals by reductive smelting in direct-current arc furnace processes are investigated using a computational modelling approach. The replacement of fossil carbon as a reductant by alternative reductants such as silicon carbide, ferrosilicon, and hydrogen is desirable for reducing direct greenhouse gas emissions from such processes, but the impact of these changes on the electrical operability of the process is poorly understood. This paper presents a study of plasma arc behaviour in the context of the ConRoast reductive smelting process for UG2 ore as well as processes for recycling of automotive catalysts, using an integrated computational modelling workflow. It was found that the freeboard gas compositions, plasma properties, and arc behaviour were all affected by the choice of reductant, particularly in carbon-free smelting using ferrosilicon or hydrogen.

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Dr Quinn Reynolds

Mintek (South Africa)

Quinn is 49 years old and holds degrees in Engineering and Applied Mathematics. He has worked in the Pyrometallurgy Division at Mintek for over 25 years. Mintek is a state-owned research institute serving the extensive mineral and metallurgical processing sector in South Africa. Quinn is also an extraordinary professor in the department of Chemical Engineering at Stellenbosch University.

His expertise includes mathematical and computational modelling of complex coupled phenomena in high temperature processes, and in particular the application of high-performance computing and open-source software platforms to pyrometallurgy. His current areas of research include magnetohydrodynamic modelling of electric arcs, multiphysics fluid flow problems in furnace tapping and phase separation, combustion modelling for metallurgical processing, and reduced order modelling for digital twin applications.

Improved control of an electric arc furnace in a PGM smelting operation

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Electric arc furnaces (EAFs) in platinum smelting contribute significantly tor overall electrical energy consumption in platinum group metal mining and processing. Improving operational efficiency and energy productivity at these operations is therefore essential for sustainability. This paper investigates the electrical control techniques used on two identical Six-in-Line EAFs, each rated at 34 MW, to assess the performance of resistance control. The goal of improving electrical control is to enhance overall furnace stability, resulting in lower specific energy consumption and, consequently, less electrical energy usage and costs. After various investigations, audits, and analyses, it was found that the resistance control on these furnaces was inconsistent due to insufficient electrode hydraulic speeds and suboptimal performance of the resistance controllers in the programmable logic control. This was caused by maintenance challenges with the electrodes' hydraulic system and variations in the mineralogy of the concentrate feed blend. The resistance control's performance was evaluated and analysed to determine if the actual resistance remained within the deadband, where the resistances mostly operated outside the upper or lower deadbands, leading to instability. This was resolved by firstly adjusting the electrodes' hydraulic speeds according to their design specifications. Secondly, the resistance controllers were fine-tuned, and the performance impact was evaluated. The results indicated that the resistance was now effectively controlled within the resistance control deadband. These interventions resulted in an annual energy savings of 8.25 GWh and a reduction in specific energy consumption of 3.03 %. This translates to energy cost savings of R 15.17 million per annum, with no capital expenditure required.

Juan Siecker

Technical Specialist Manager and Extraordinary Senior Lecturer
ETA Operations and North-West University

Juan Siecker started working in 2016 as an Electrical Engineer at ArcelorMittal South Africa, where he obtained valuable hands-on experience in the Electrical Engineering discipline. He obtained his PhD degree in Electrical Engineering in 2023. In 2022, he started to work as a Project Engineer for ETA Operations in terms of energy efficiency optimization in the mining and mineral processing sector. He mostly focused on energy efficiency improvements in the platinum smelting and refining processes. Currently, he is working as a Technical Specialist Manager, still focusing energy efficiency improvements on the platinum smelting and refining processes, as well as providing technical support to various other Engineers working in similar processes. Juan is also appointed as a senior extraordinary part-time lecturer at the North-West University.

Assessing the performance of a PGM Smelting Furnace

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With deteriorating ore quality it is expected that future concentrate blends will be lower in base metals and sulfur, and higher in chromium. There is uncertainty about whether current technologies can smelt future blends; do we need new technologies, or can current technologies, with minor changes, still deliver the required throughput?

In order to gain insights into the performance and behaviour of a platinum group metal (PGM) smelter furnace, a fully coupled multiphysics model was developed. The model seeks to describe each of the main physical phenomena within a typical PGM smelting furnace. Hence, the model includes representations of the slag bath, matte bath, black-top, freeboard, refractories, and electrodes. The physical phenomena solved for include fluid flow within the slag and matte baths, radiation within the freeboard, thermal conduction through the refractories, and magnetohydrodynamics to approximate the flow of current, current-generated magnetic fields, electromagnetic Lorentz forces, Joule heating and power density distributions through the various furnace regions.

Given that the black-top is the region within the furnace where the majority of phase change and energy absorption is expected to occur, a novel throughput model was developed. The temperature profile through the black-top is described by solving the full global energy conservation equation, effectively describing both the transport of energy and the magnitude of energy associated with phase change. The temperature-enthalpy relationship governing the phase change energy is approximated using computational thermochemistry. This throughput model is therefore capable of estimating the location and magnitude of energy absorbed due to phase change and approximating the spacially varying rate of smelting through the black-top.

The model was validated against measured input power, heat losses, temperatures, and throughput of a typical PGM smelting furnace. A large design-of-experiments (DOE) was then performed to assess the main drivers and system sensitivities, and investigate the influence of changes in the concentrate on throughput. The main system parameters that were considered as part of DOE included slag material properties (viscosity, thermal conductivity, and thermal expansion), matte material properties, bath depths, freeboard dust loading, slag operating temperatures, resistance set-points, and black top material properties.

Willem Roos

Senior Mechanical Engineer
Ex Mente Technologies

Willem Roos is a mechanical engineer with a background in high-temperature thermochemistry and its integration into multiphysics models. He leads the Multiphysics Modelling Function at Ex Mente, where they are responsible for developing and advancing solvers that combine thermodynamics, thermochemistry, fluid flow, heat transfer, and electromagnetics to investigate large and complex industrial systems.

Through his Ph.D. research at the University of Pretoria, Willem designed and implemented an acceleration algorithm that enables a large number of multi-component, multi-phase thermochemical equilibrium calculations to be efficiently included in multiphysics simulations. This development will make it possible to capture the chemical, thermal, and physical interactions of industrial furnaces and reactors at a level of detail in multiphysics models that was previously impractical.

At Ex Mente, Willem applies the developed solvers and methods to support industry in understanding and optimising the behaviour of furnaces, reactors, and other high-temperature equipment. His work focuses on improving capabilities in areas such as furnace heat-up modelling, electromagnetic effects, throughput analysis, and sensitivity studies, providing clients with deeper insights into process performance, energy efficiency, and equipment design.

Automated statistical anomaly detection in an integrity monitoring application for a furnace

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Furnace integrity is a critical concern in high-temperature metallurgical operations, directly impacting safety, campaign life, and business continuity. As such, there is a need for early detection and prevention of failures. Due to the high number of data sources, drawing connections between signal behaviour and failure events is challenging. In one such operation, integrity engineers were manually reporting on data from over 500 instruments — a process that was time-consuming, subjective, and prone to human error. The aim of this study was to develop a simple algorithmic solution to streamline the manual integrity monitoring process by automating the detection of specific anomalous timeseries behaviours that integrity engineers were manually identifying. Secondly, the aim was to integrate these algorithms into a prototype reporting tool, allowing an integrity engineer to review detected anomalies and prepare material for peer review. An analysis of a sample of the manual reports revealed six timeseries behaviours – five univariate and one multivariate - for which six statistical anomaly detection rules were specifically designed. Four univariate, parametric rules were designed, and two non-parametric, multivariate rules were designed. The parametric rules are designed to quantify statistical significance with respect to a historical reference period – two years in this study. All six rules have tuneable parameters to enable adjustment per sensor. The rules were tested across a series of temperature, flow and displacement sensors. With specific comparison to the manual reports, 76% of human-detected anomalies over a four-month period were automatically detected, with five of the six undetected anomalies confirmed to be insignificant on further review by the integrity engineer. These algorithms were implemented into a proof-of-concept system that extracts live data from site systems to perform cloud-based computation. Anomalies were automatically detected and presented to the engineer through a user interface designed around asset hierarchy and risk areas. By automating routine analysis, the system frees up capacity to focus on risk mitigation.

Keywords: furnace integrity, anomaly detection, machine learning, operations technology

Thessy Moodley

Regional Director - Digital
Hatch

Thessy Moodley brings 18 years of post-qualification experience as a digital transformation consultant, control and instrumentation engineer in various industries such as pulp and paper, bulk materials handling, oil and gas, and smelting industries through all asset phases including early engineering, execution, commissioning, start up and optimisation. His working experience has spanned projects and leadership roles in South Africa, Norway, Guatemala, Australia and the United Arab Emirates.

Under his leadership, as Regional Director for Digital in Africa, Europe and the Middle East, Hatch's Digital team in the region has grown from inception to execute Industry 4.0 based projects in optimisation, advanced planning and scheduling, digital value chains, integrated operations, artificial intelligence and digital twins for the metals, energy and infrastructure sectors. Thessy holds a Master's Degree in Control Engineering.

Comparative study of the interaction of alumina-chrome refractories with PGM smelter slag

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This study investigates and compares the corrosion and wear mechanisms of two commercial alumina-chrome (Al_2O_3–Cr_2O_3) refractories—designated Refractory A and Refractory B—during exposure to PGM (Platinum Group Metal) smelter slag at 1550°C in a Top-Blown Rotary Converter (TBRC) furnace. The main objective was to understand how microstructure, mineral phases, and chemical composition influence refractory corrosion behavior in smelting environments. Both refractories were exposed to real PGM smelter slag under dynamic furnace conditions for repeated heating cycles. Post-exposure analyses were carried out using Scanning Electron Microscopy with Energy-Dispersive Spectroscopy (SEM-EDS) to examine slag penetration, phase transformations, and reaction layers. FactSage™ 8.3 thermodynamic simulations were performed to model the slag–refractory interactions and predict phase stability at equilibrium. Results showed that Refractory A, with higher Al_2O_3 and lower Fe_2O_3–MgO contents, developed protective spinel layers of $(Mg,Fe,Ni)(Cr,Al)_2O_3$ and $(Mg,Fe)Al_2O_3$ around alumina grains, restricting slag infiltration. In contrast, Refractory B, richer in Cr_2O_3, Fe_2O_3, and MgO, formed coarse spinel bands that failed to inhibit Al_2O_3 dissolution, leading to extensive grain and matrix degradation. Thermodynamic predictions confirmed that corrosion proceeded primarily through alumina dissolution, with higher dissolution predicted for Refractory B. The findings demonstrate that microstructure and high-temperature phase stability significantly influence refractory performance in PGM smelting, with Refractory A showing superior resistance to slag attack.

Factors influencing campaign life of PGM furnace hearths

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For a platinum group metals primary concentrate smelting furnace, the campaign of the crucible hearth represents the campaign life of the vessel. A hearth relining requires a complete furnace shutdown and can require three to five months of furnace downtime to complete the reline and recommission of the vessel. The associated sustaining capital costs represent a major contributor to the cost of operation (total cost of ownership). Additionally, the rebuild frequency and duration is a significant component of the furnace's long term operating factor which influences throughput and concentrate stockpile levels. Unplanned failures will exacerbate the business interruption and introduces significant safety risk to operators.

This paper outlines the factors that predominately influence the campaign life of a furnace hearth, including design, process stability, monitoring, and maintenance. Furthermore, this paper provides examples of how knowledge of these factors combined with disciplined decision-making can be used to minimise business interruption and extend furnace hearth campaign life.

Keywords: campaign life, PGM, hearth, smelting, furnace, crucible

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Asset Performance Specialist, Furnaces
Hatch

Michael is a mechanical engineer in Hatch's Asset Performance Management (APM) group focusing on pyrometallurgical furnaces. The APM group provides services to help clients optimize the performance of their operational assets. Michael's furnace engineering experience includes: site inspections, modelling, and data analysis to assess condition, remaining campaign life, and planned maintenance interventions; root cause investigations to assess equipment performance and identify opportunities for technology improvements, and operations support in the form of condition monitoring and technical advisory to improve reliability, productivity, and safety.

Michael graduated from the University of Waterloo in Canada with a Master of Applied Science specializing in radiation heat transfer. Michael's research developed the field of quantitative optical gas imaging (QOGI) using mid-wavelength infrared (MWIR) cameras to image and quantify greenhouse gas emissions, particularly methane from upstream oil and gas production. Michael's contributions demonstrated the advantages of multispectral infrared imaging in species differentiation and quantification on non-ambient temperature gases, and the challenges with uncooled multispectral filters and velocimetry algorithms.

Challenges in crucible- and pilot-scale refining of a PGM-bearing iron alloy

M.S. Moholwa[1], S.P. Tsebe[1], E. Matinde[1,2]
[1]Mintek, South Africa
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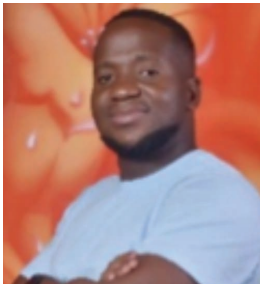
Platinum group metals (PGMs) have a wide range of applications, primarily due to their catalytic properties and resistance to corrosion. The secondary production of these metals typically involves recycling of secondary resources such as spent automotive catalysts (autocats). The process normally involves smelting of spent autocats with a reductant, fluxing reagents, and a source of collector alloy. An investigation was undertaken to evaluate the technical feasibility of refining a PGM-containing iron alloy recovered from recycled spent autocats. The study involved investigating the technical feasibility for upgrading the PGMs' content of the alloy from 3% to 20% through oxygen refining. The chemical composition of the start alloy comprised of approximately 90% Fe, 5% Cu, 0.6% Ni, 0.2% Co, and 3.4% PGMs. The test work involved a series of preliminary converting tests at crucible scale followed by tests at pilot scale in a top blown rotary converter (TBRC). The tests were conducted in three stages. Stage 1 tests were carried out in an induction furnace to establish optimum processing conditions such as oxygen delivery rate, operating temperature, and flux addition. Stage 2 tests were also carried out in an induction furnace to estimate deportment of PGMs and base metals to product alloy and slag. Stage 3 tests were carried out in a TBRC to facilitate preparation of 1–2 kg of the final upgraded alloy with the desired PGMs grade. The results showed that it was not technically feasible to extensively refine the alloy at the crucible scale due to consistent premature crucible failure. Tests at pilot scale produced excessively oxidised alloys due to lack of reliable method of measuring the oxidation efficiency.



Matale Samuel Moholwa

Senior Engineer: Techology Demonstration Group
Mintek

Matale Samuel Moholwa is a senior engineer under the technology demonstration group in the pyrometallurgy division at Mintek. He holds a master's degree in chemical engineering and has been employed at Mintek since 2018. In his current role, Sam conducts research on pyrometallurgical process involving various commodities and different smelting technologies. His experiences and interests are but not limited to research & development, project and people management, process engineering design, equipment selection, process optimization, commissioning of new and modified plants, feasibility studies and business development. Sam has presented at international conferences which include the 4th Manganese school and TMS conference.

Cooling innovation in practice: A case study on composite copper-graphite cooler performance before and after a PGM furnace partial sidewall rebuild

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[1]Tenova Pyromet, South Africa
[2]Sibanye-Stillwater, South Africa

Sibanye-Stillwater recently completed a partial sidewall rebuild on Furnace 1 at its Marikana smelter complex. The project involved matte taphole maintenance, which required the removal and subsequent replacement of 18 composite copper-graphite coolers and a section of the lower refractory sidewall. These composite copper-graphite coolers are a newly developed cooling design by Tenova Pyromet, and this rebuild project provided valuable insight into the performance of the composite coolers. The novel composite cooler design was implemented to serve as a safeguard against localised wear and corrosion in the furnace sidewall, particularly at the slag-concentrate interface, where chloride-accelerated sulfidation has been identified as a dominant degradation mechanism affecting the copper cooling elements. The composite cooler design is unique in that all the exposed sides of the water-cooled copper elements are fully encapsulated in graphite, which protects the copper from corrosive sulfur- and chlorine-bearing gases and condensates. This sidewall cooling system was designed to improve corrosion resistance, stabilise freeze-lining formation, and extend the campaign life of the furnace sidewall. The partial sidewall rebuild was executed during a planned maintenance shutdown with the main objective of replacing the matte taphole lintel bricks. This paper serves as a case study that compares and evaluates the operational performance of the composite coolers before and after the rebuild. The installation method is discussed to highlight the approach taken to ensure a sound installation while minimising downtime, as well as to present some lessons learned in the process.

The full paper will be published in the SAIMM Journal

Pieter Bezuidenhout
Senior Project Engineer
Tenova Pyromet

Driaan Bezuidenhout is a Mechanical Engineer with eight years of experience in the pyrometallurgy industry. He began his career at Mintek's pyrometallurgy division, where he specialized in the design and operation of AC and DC pilot furnaces. During his time there, he collaborated with multidisciplinary teams on projects ranging from mineral processing to hydrometallurgical applications. Page 2 Tel: +27 11 538 0232 | Email: sam@saimm.co.za | Website: www.saimm.co.za Physical Address: 7th Floor, Rosebank Towers, 19 Biermann Avenue, Rosebank, 2196

In 2022, Driaan joined the Tenova Pyromet team as a Project Engineer. Since then, he has contributed to the design of equipment for large-scale furnace plants and participated in furnace rebuild projects. This hands-on involvement has provided him with valuable insights into the operational demands of furnace systems, enabling continuous improvement of future designs.

Evaluation of an alternative furnace cooling medium for enhanced operational safety

K.C. Maluleke[1], H. Joubert[1], P. Jonker[1], G. Tawane[2], X.C. Goso[2]
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[2]Mintek, South Africa

Many modern furnace designs incorporate coolers made from steel or copper to stabilise the refractory and promote the formation of a protective slag freeze layer. Typically, water is used as the cooling medium in these systems, although a few installations have adopted synthetic oils as an alternative. Water-cooled systems integrated into the furnace crucible pose safety risks in the event of unintended water leakage. Such leaks can cause equipment damage, physical injuries, and even fatalities, due to explosions caused by hot liquid metal or matte being mixed with water. To mitigate these risks, alternative cooling media have been proposed in industry, including ionic liquids and mono-ethylene glycol (MEG). In this study, Tenova Pyromet, in collaboration with Mintek, evaluated the cooling performance and safety characteristics of a 70% MEG, 30% water mixture (MEG70). A pilot-scale copper test cooler was operated under controlled flow conditions at bulk temperatures of 68°C and 83°C to measure heat flux, copper temperature, and heat transfer coefficients. Explosion trials were also conducted to compare the behaviour of MEG70 and water when in contact with molten matte. The results showed that MEG70 provides comparable cooling performance to water, though requiring higher flow velocities. At elevated bulk temperatures, MEG70 demonstrated improved heat transfer but with increased hydraulic losses. Importantly, safety trials confirmed that, unlike water, MEG70 does not trigger violent explosions with molten matte; instead, it burns in a controlled manner. These findings demonstrate that MEG offers a technically viable and significantly safer alternative to water for deep furnace cooling applications.

Kgomotso Charlotte Maluleke

Technical Sales Engineer
Tenova Pyromet

Kgomotso Maluleke is a Metallurgical Engineer with BSc and MSc in Metallurgical Engineering from the University of the Witwatersrand and over five years hands-on pyrometallurgy base metals experience. Kgomotso holds a BSc and MSc in Metallurgical Engineering from the University of the Witwatersrand, and currently works as a Technical Sales Engineer at Tenova Pyromet. Kgomotso began her career at Mintek as a Process Engineer, where she focused on process development and optimisation in both pyrometallurgical and hydrometallurgical environments. In this role, she gained hands-on experience with a broad range of commodities, including PGMs, base metals, vanadium, rare earth elements, manganese, and autocatalytic converters. In 2023, Kgomotso joined Pyromet as a Technical Sales Engineer, where she supports customers across the base metals sector by preparing technical and commercial proposals, developing cost estimates, and advising on process improvements and equipment solutions. This role enables her to leverage her practical background in extractive metallurgy to help clients tackle their unique operational challenges. Her ongoing client engagements and exposure to diverse projects offer valuable insight into the evolving requirements of the industry, allowing her to contribute to continuous improvement and innovation in the solutions delivered by Pyromet.

Optimising reverts addition in PGM smelting: Strategies for enhanced furnace stability and efficiency

C. Sikiotis[1], G. Mulder[1], J. Bezuidenhout[1], S. Matutu[2], T. Sisya[2]
[1]Hatch, South Africa
[2]Selous Metallurgical Complex, Zimbabwe

Processing and recycling of reverts in platinum group metal (PGM) smelters is essential for the recovery of PGMs and base metals. However, if reverts are recycled directly to the furnace, the feed methodology and rate of reverts addition can significantly influence process stability, energy efficiency, and refractory longevity. The process and electrical impacts of batch vs continuous reverts feeding strategies have been investigated for the Zimplats Selous Metallurgical Complex, with the key findings summarised in this paper.

The results indicate that a localised batch feeding strategy can lead to process instabilities and increased operational risk. In contrast, implementing a continuous and well-distributed reverts feed strategy can lower slag operating temperatures, resistivity, and viscosity, while supporting overall process stability. The findings provide a practical framework for optimising reverts handling systems in PGM smelters.

Christella Sikiotis
Process Engineer, Pyrometallurgy
Hatch Africa (Pty) Ltd

Christella is a chemical engineer with experience in the pyrometallurgical industry, focusing on PGM smelter design and process development. Her work includes operational support, process control and optimisation, techno-economic evaluations/trade-offs, Metsim and FactSage™ modeling, development of mass and energy balances, sizing and scheduling of furnaces and Peirce-Smith converters, and analysis of operational data to drive performance improvements. Christella has also been involved in the development of SO_2 fixation flowsheets, as well as technology, performance, and safety risk reviews for novel metallurgical processes. She has conducted various pyrometallurgical studies for operational smelters and has contributed to smelter process control and optimisation through the development of a smelter process control model that supports plant optimisation and operational efficiency.

Reductive matte smelting of UG2 concentrate using Al, FeSi, and SiC reductants

S.B. Nkosi, X.C. Goso
Mintek, South Africa

Merensky Reef, in the Bushveld Complex of South Africa, has been used as the primary source of platinum group metals (PGMs) over the years; however, this resource is becoming depleted. Pyrometallurgical extraction of PGMs from a Merensky concentrate has been conducted through the conventional matte smelting process, which is designed for concentrates with high sulfur and low chrome contents. Upper Group 2 (UG2) Reef in the Bushveld Complex is an alternative PGM resource, but has lower sulfur and high chrome contents, which make this resource challenging for processing using the conventional process. In the this paper, metallothermic reductive matte smelting of UG2 concentrate was investigated using Al, FeSi, and SiC as reductants for increasing the matte fall to compensate for lower sulfur content and improving the solubility of chrome in the slag. FactSage thermochemical simulations and experimentation were conducted to complete the investigations. Smelting blends of UG2 concentrate and respective reductants at 100:1 and 100:5 mass ratios were processed at 1600°C, in an inert (argon) atmosphere. Empirical smelting products, i.e., slags, mattes and matte-alloys were subjected to chemical and mineralogical characterisation. Both simulation and empirical results showed an increase in matte fall with reductant addition. Higher reductant additions resulted in the highly undesirable formation of both matte and alloy, with PGMs primarily deporting to the iron-rich alloy. Simulation results showed that a chrome-spinel [$(Mg)(Cr,Al)_2O_4$] was stable in the slag at 0% to 4% reductant additions, above which the spinel dissolved. Mineralogical analysis results showed that chrome-spinel in the slags produced using Al reductant, and FeSi at 1% addition was generally stable. The observed stabilisation of the spinel was attributed to the formation of Al_2O_3 during the aluminothermic smelting. Spinel was not detected in the slags produced using SiC reductant. The results show that SiC (and FeSi, to a lesser extent) can be effectively used for smelting UG2 concentrate, resulting in increased matte fall and solubility of chrome-spinel in the slag. Further work is recommended to optimise SiC (and FeSi) reductant additions to avoid the complication of producing separate matte and alloy during the smelting. Phase relations in the slags produced from reductive matte smelting of UG2 concentrate using these reductants should also be investigated to understand the conditions that promote the solubility of the spinel in the slag.

Sanele Nkosi
Scientist
Mintek

Sanele Nkosi holds an MSc in Chemical Engineering from the University of Cape Town. In her career, Sanele has been involved in many projects for the beneficiation of different resources including ferrous minerals, industrial minerals and precious materials, base and technology metals-bearing primary and secondary materials, and energy minerals like coal. Her research interests include extractive metallurgy of titaniferous magnetite for vanadium, steel and titania production; coal characterisation and carbonaceous reductant reactivity testing; general chemical, thermal, and mineralogical characterisation of materials; and high temperature experimentation including reaction kinetics and mechanisms in gas-solid systems, smelting and refining. She is currently working on a PGM research project involving the investigation of alternative reductants that can be used in the PGM matte smelting process. This project involves thermochemical simulations, 200 g laboratory-scale smelting tests, and 15 kg smelting tests in a 100 kVA induction furnace.

Commissioning the Zimplats smelter expansion

M. Crafford[1], M. Monobe[1], G. Erasmus[1], S. Matutu[2]
[1]Hatch, Johannesburg, South Africa
[2]Zimplats, Selous, Zimbabwe

Zimplats, in collaboration with Hatch, undertook a fast-tracked expansion of its Selous Metallurgical Complex smelter to triple its processing capacity. The project included the installation of a new 38 MW six-in-line Hatch electric furnace, flash dryer, Peirce-Smith converters, and auxiliary systems. Commissioning was completed late 2024, achieving stable production within months of initial matte tapping. This paper presents the commissioning strategy, challenges encountered, and solutions implemented under tight schedule constraints and overlapping operational activities.

Key issues such as compressed air system overload, deferred SO□ abatement integration, and slag granulation inefficiencies were resolved through data-driven diagnostics, practical implementation of solutions, and collaborative engineering. The commissioning methodology and outcomes offer valuable insights for future smelter projects, particularly in balancing operational continuity with aggressive execution timelines. The project sets a benchmark for PGM smelting projects, with implications for industry-wide practices in utility design, emissions control, and commissioning under constrained conditions.

Keywords: Smelter expansion, commissioning, collaboration

Minèt Crafford

Process Engineer
Hatch

Minèt has been involved in various gas handling and metallurgical processing plant design projects. Where the gas handling projects primarily focused on designing, evaluating and debottlenecking of off-gas systems and SO_2 abatement plants. Minèt has worked on projects ranging from desktop studies to execution phase projects. As process engineer she has experience in developing process deliverables, operating cost estimates, functional specifications and control philosophies for a wide variety of operations.

Most recently, Minèt was involved in the commissioning of the new 38 MW furnace and its wraparound facilities as part of the Zimplats Smelter Expansion project.

An overview of pyrometallurgical research on PGMs at Mintek: from conceptualisation to demonstration

X.C. Goso, S.P. Tsebe, B.S. Xakalashe, E. Matinde
Mintek, South Africa

Mintek's pyrometallurgical research, development and innovation (RDI) on the production of platinum group metals (PGMs) was reviewed to provide insights on testing capabilities and flagship technologies. Pyrometallurgical RDI is conducted through a dedicated Pyrometallurgy Division, which implements Mintek's strategy for conducting RDI that promotes responsible and sustainable production of PGMs. Mintek has been providing high-impact and cutting-edge pyrometallurgical RDI to support the South African and global PGM industry since the early 1970s. Thermochemical simulation software and computational modelling tools, high temperature laboratories equipped with world-class RDI infrastructure, and a range of pilot-scale electric arc and rotary furnaces are utilised for developing pyrometallurgical PGM projects from conceptualisation to full demonstration, i.e., moving from TRL 1-7/8 on the global Technology Readiness Level index. Towards supporting the sustainability of the PGMs industry, Mintek developed and demonstrated the flagship ConRoast process up to the 3 MW DC arc furnace scale. Cutting-edge RDI has also been conducted towards the development of sustainable processes for secondary PGM-bearing resources, including the recycling of automotive catalysts and electronic waste. Pyrometallurgical RDI at Mintek is backed up by extensive analytical chemistry and mineralogical analysis support.

Xolisa Goso

Head: Technology Development, Pyrometallurgy
Mintek

Dr Xolisa Goso completed an MTech degree in chemistry at the University of Johannesburg (UJ) and a PhD in Chemical Engineering at the University of Cape Town (UCT). He has been with Mintek for over 17 years and currently works as Head: Technology Development in the Pyrometallurgy Division.

Dr Goso is a member of SAIMM, a published author of journal and conference papers, and has presented at local and international conferences. In his career, he has been involved in many projects for the beneficiation of various resources, including ferrous minerals, industrial minerals and chemicals, precious metals, base and technology metal-bearing primary and secondary materials, and energy minerals. His research activities include: extractive metallurgy of titaniferous magnetite for vanadium, steel and titania production; pyrometallurgical extraction of PGMs from primary and marginal/ secondary ores; thermochemistry of materials; phase relations and pyro-hydrometallurgical beneficiation of primary and secondary materials; coal characterisation and carbonaceous reductant reactivity testing; general chemical, thermal, and mineralogical characterisation of materials; and high-temperature experimentation including refractory-material interaction studies, and reaction kinetics and mechanisms in gas-solid systems, smelting and refining.

The influence of impeller geometry on stirred media mill performance

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[1]Mintek, South Africa
[2]University of Cape Town, South Africa
[3]University of KwaZulu-Natal, South Africa
[4]Tshwane University of Technology, South Africa

The flow behaviour of a granular ensemble in stirred mills is influenced by operating conditions such as the tip speed, filling level and bead size distribution. The flow behaviour is also influenced by the stirred mill design features such as rotor/impeller geometry and liner wall of the chamber. The flow behaviour creates the collision environment, which effectively drives the size reduction of mineral ores mainly by attrition breakage. Stirred media mills are common in platinum group metals (PGM) minerals processing plants for fine/ultrafine grinding purposes. It is envisaged that the PGM industry will see more installation of stirred media mills for tailing treatment purposes in the future. The size reduction ratio and the efficiency of energy utilisation of a stirred mill are influenced by the collision environment inside the mill. Discrete element method simulations were conducted (using Ansys ROCKY) to explore the collision environment in stirred mills fitted with pin disc impellor, perforated disc impellor and modified disc impellor.

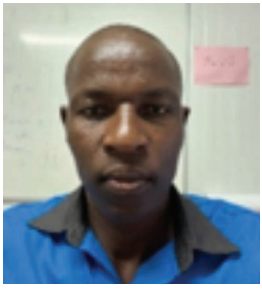
Collins Machiri Lekgoro
Metallurgical Technician
Mintek

Collins is a Metallurgical Engineering Technician in the Comminution Group within the Mineral Processing Division at Mintek. He holds a National Diploma in Metallurgical Engineering from the Vaal University of Technology and a B-Tech degree in Metallurgical Engineering from the Tshwane University of Technology. He has worked for Anglo American Research for two years and Anglo Platinum Operations (Concentrator) in the production department for two and a half years before joining Mintek in November 2023.

Comminution behaviour of the middle group ores

P.C. Siwela, M.M. Ramakokovhu, M.L. Teffo
Tshwane University of Technology, South Africa

The Middle Group chromitite ores are a significant source of chromium and platinum group metals. However, their complex mineralogy and variable texture pose challenges for efficient comminution and downstream processing. This study investigates the comminution behavior of four MG ore types (MG1, MG2, MG3, and MG4A) using Bond Work Index, Uniaxial Compressive Strength, Abrasion Index, and JK Drop Weight Test. Results indicate that MG ores exhibit challenging comminution characteristics, evidenced by high Bond Work Indices and variable impact breakage behavior. These findings align with observations by Mwanga et al. (2017), who emphasized the importance of understanding ore characteristics for comminution optimization. Notably, MG1 exhibits the lowest energy requirements for comminution, while MG2 and MG3 demand more energy-intensive processing. These variations underscore the need to tailor comminution circuits to ore-specific properties. Recommendations include optimizing crusher selection, configuration, and operating parameters to minimize energy consumption and wear. Future research should explore alternative comminution methods, such as high-pressure grinding rolls or stirred media mills, and investigate the correlation between mineralogy, JK parameters, and other comminution properties for a comprehensive understanding of MG ore breakage behaviour.



Phumlani Siwela
Process Superintendent
Minopex

I am a seasoned metallurgical environmental professional with 16 years of experience in the mining industry. Starting as a student, I demonstrated unwavering dedication and perseverance, rising through the ranks to attain the esteemed position of Superintendent.

Throughout my illustrious career, I have gained extensive expertise in various commodities, including Platinum Group Metals (PGM), chrome, and coal. This diverse experience has equipped me with a unique understanding of the complexities and challenges associated with different mining operations.

A holder of two master's degrees, I have earned an Mtech in Metallurgical Engineering and an MBA. This exceptional academic background has provided me with a strong foundation in both the technical and business aspects of the industry.

As a respected leader, I continue to drive innovation and excellence in metallurgical environmental management, leveraging my expertise to optimize processes, ensure sustainability, and foster growth in the mining sector.

Improving PGM recovery through optimised solid liquid separation

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[2]Valterra Platinum, South Africa
[3]Solenis, South Africa

As the platinum metals group (PGMs) market faces challenges of demand, it is imperative that refinery operations must ensure continuous improvement in process efficiency and reduce metal losses. This paper presents a comprehensive approach to a technical evaluation and optimisation of a PGM refinery solid-liquid separation process of an effluent stream. The study was conducted in two parts: bench-scale laboratory test work to identify the flocculant chemistry, and a full-scale plant validation trial of the flocculant chemistry.

Initial bench-scale laboratory test work showed that Magnafloc 10 was the flocculant of choice for improving settling rates, underflow density, and overflow clarity. Magnafloc 10 consistently delivered superior performance over different feed samples, compared to other flocculants. It achieved overflow turbidity clarity below 100 NTU, and underflow density improvement of up to 5%. Dosing profiles and settlement rate analysis validated Magnafloc 10 for suitability for full scale plant trials.

Full-scale plant trials, firstly focused on plant operational readiness for Magnafloc 10 flocculant make-up and identifying an effective dosing philosophy. The plant make-up unit was identified as functional but requiring minor maintenance and calibration due to the use of an incompatible product prior to Solenis. The findings from the plant assessment also revealed critical limitations arising from a lack of flow meters, and monitoring tools such as turbidity and density meters. To address these challenges, screw feeder calibration and settling rate protocols, and dosing strategies were investigated. The second part of the full-scale plant trial focused on optimisation of the Magnafloc 10 dosage. The full-scale plant trial results achieved a suspended solids percentage removal 97% and underflow density of 1.15 g/L at a dose rate of 2.2 g/T. The full-scale plant application of Magnafloc 10 revealed there were additional benefits in the dewatering filter plant cake moisture content.

This paper contributes valuable insights into the practical challenges and solutions associated with improving PGM recovery from solid-liquid separation processes within refinery operations using a flocculant.

Mfandaidza Hove

Metallurgical Specialist
Anglo American- Technical Solutions

A metallurgical specialist with a passion for education!
Mfandaidza Hove obtained his BSc and MSc qualifications from the National University of Science and Technology (NUST) in Zimbabwe. He briefly worked for the Roasting Plant Corporation, where he worked on the first pilot plant for the bioleaching of refractory gold ore. He later joined the Zimbabwe Iron and Steel Company as a Fuels Engineer responsible for heating fuels supply and distribution, power station operations and effluent treatment. After two years he went back to school to do his MSc, and upon completing the MSc, he moved into academia as a lecturer.

Currently Mfandaidza is working as a Metallurgical Technical Specialist at Anglo American Technical Solutions in Johannesburg where he has spent more than 17 years in research and development, technical and operation of hydrometallurgical and refining processes of base and precious metals. At the same time, he has also developed separately or as part of the same process on the treatment of effluent water emanating from the metallurgical processing to produce clean water and reuseable solid by products instead of waste residues. These efforts have helped the company achieve its Zero Waste to Landfill by 2020 target. Recently we have developed a process for the recovery of significant PGM values from waste residues, a first for Valterra Platinum's PMR Operations.

Passionate about education, he is an external examiner for a number of universities in South Africa for Chemical engineering at both honours and master's levels. Currently volunteer/part time lecturer for the MSc in Metallurgical Engineering Program at the University of the Witwatersrand. Former Chemical Engineering academic advisory board member for the University of Johannesburg (2011 -2017).

Investigating the impact of stirred milling to improve the fineness of the grind for PGM tailings reprocessing - IsaMill case study

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[2]Tailings Technology (Pty) Ltd, South Africa

IsaMills have been used in the Mill-Float circuits in the platinum industry to ensure that the platinum group minerals (PGM) are liberated and available for the subsequent flotation stages. A growing trend of reprocessing tailings to recover both chromite and PGMs in the UG2 ore, one of the local platinum-bearing ores, has been observed. The tailings are either reprocessed without any milling stage or a ball mill is used as a preparatory stage for minimal grinding to polish the particle surfaces. Due to the fine-grained nature of PGMs, achieving adequate liberation often requires grinding below 45 µm. High energy consumption is required to grind to the appropriate levels of fineness using ball mills, and the product often has a significantly high amount of slimes, which leads to high losses of valuable minerals downstream. This paper presents the results of tests performed using the IsaMill to produce products with P80 values of 71, 52, and 28 µm, which were subjected to batch flotation tests to evaluate the effects of grinding the tailings before reprocessing on recovery, along with the associated energy-grind relationships. 4E recoveries in the order of 70% were obtained from the tests where stirred milling was applied in the preparation stage, compared to 25-30% for the tests that did not involve milling or the tests that had a ball mill (P80=83 µm and 45 minutes grinding time) before the flotation stage. The high recoveries observed were largely due to the enhanced liberation of PGM-bearing phases. The study indicates that stirred milling is a viable strategy for PGM tailings reprocessing, provided that operational conditions are tuned for energy efficiency.

Keywords: IsaMill, Tailings, Liberation, Recovery, Reprocessing

Kabeli Irvin Mohapi

MSc Chemical Engineering Student
University of Cape Town-Centre for Minerals Research

Kabeli Irvin Mohapi is a dedicated Chemical Engineering graduate and postgraduate researcher, currently pursuing a Master's degree in Chemical Engineering at the University of Cape Town with the distinguished support of the Mastercard Foundation Scholars Program. With a strong emphasis on sustainable resource recovery and process optimisation, Mr. Mohapi is passionate about utilising science and technology to tackle some of the most urgent challenges in the mining industry, particularly in waste valorisation and circular economy principles.

As a Mastercard Foundation Scholar, Kabeli Mohapi has demonstrated exceptional academic ability, leadership, and a clear commitment to making a transformative impact on their community and the broader African continent. This prestigious scholarship has provided both the platform and inspiration to pursue high-impact research in mineral processing and to develop solutions that promote inclusive and sustainable growth.

Kabeli's current research focuses on the reprocessing of Platinum Group Minerals (PGM) tailings, evaluating the effect of fine grinding technologies on mineral liberation and flotation performance. His work specifically investigates

the use of stirred media mills, namely the IsaMill and HIGMill, under varying energy input conditions. Through a systematic study of comminution parameters such as stress intensity, stress energy, and specific energy, the research offers valuable insights into how fine particle breakage mechanisms influence downstream flotation efficiency, selectivity, and concentrate grade.

Key outcomes of the project include the development of energy-based models for optimising grind size, the application of stress models to quantify mechanical environments within mills, and the use of kinetic data to predict flotation behaviour. These findings are intended to support industry efforts to recover value from tailings and improve the sustainability of PGM extraction.

In addition to technical expertise in flotation, comminution, and metallurgical testing, Kabeli has gained practical experience in laboratory-scale experimentation, data analysis, and mineralogical interpretation. His approach combines experimental design with engineering analysis to solve complex metallurgical problems, with an emphasis on reproducibility, scalability, and environmental responsibility.

Kabeli has actively contributed to academic seminars. He is deeply interested in knowledge exchange between academia and industry and aspires to play a bridging role by translating research insights into applied technologies that can be adopted by mining operations across Africa and beyond.

Beyond research, Kabeli Irvin Mohapi is an advocate for youth empowerment and equitable access to education. As a Mastercard Foundation Scholar, he has been involved in mentorship programs and STEM outreach initiatives aimed at inspiring the next generation of African scientists and engineers. With a long-term vision of contributing to sustainable mineral development and technological innovation in Africa, Kabeli intends to pursue a career in process optimisation, research and development, or technical consulting within the mineral processing and metallurgical sectors.

Blower system energy cost improvement in platinum group metal concentrators

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[1]ETA Operations (Pty) Ltd, South Africa
[2]North-West University, South Africa

The South African platinum mining sector relies on energy-intensive processes to extract, concentrate, and refine minerals. A significant portion of this energy is consumed during mineral concentrate processing. To remain competitive, mining companies must implement energy management systems that reduce their energy consumption, whilst maintaining production performance.

This paper presents an integrated solution to reduce energy consumption in flotation circuit aeration blower systems. A practical methodology was developed and implemented to guide the investigation, classical analysis, and simulation where necessary. This approach also supported the testing and roll-out of energy-efficiency initiatives. The method draws from current operating principles in compressed air management in large underground mines.

Implementation resulted in control strategy adjustments that enhanced energy efficiency, reducing mean electricity costs over the case studies by R500 000 during the first six months of the year. Following the current trend, overall cost savings of R4 million are expected for the year.

The results underscore the potential for significant energy- and cost-savings through targeted control improvements, demand and supply matching, and demand reduction through network maintenance in aeration systems across varying orebody types.

Keywords: Energy, Cost Improvement, Concentrators, Flotation, Blowers, Positive Displacement, Centrifugal

William Henry Sterrenberg

Engineer and PhD candidate
ETA Operations and North-West University

Liam Sterrenberg is a Senior Project Engineer with a strong track record in energy management, process optimization, and engineering execution within the South African mining industry. He has contributed to a range of greenfield projects and operational improvement initiatives across both underground and mineral processing environments, with a focus on platinum group metals. Liam's expertise includes utility cost reduction, compressed air optimization, power factor correction, and ISO-aligned energy strategies. He applies a data-driven, practical approach to improve operational performance, reduce energy costs, and support long-term sustainability goals in energy-intensive mining operations.

PGM Ore flotation using simulated long water cycles

M. Safari[1,2], M.F. Moya[1,3]
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[3]University of Cape Town, South Africa

The mining industry is forced to have water management strategies for their operations as a response measure to the challenges with the availability of freshwater resources. It has been reported that the mining industry is one of the largest contributors to the discharge of contaminated water to the environment. To reduce this discharge, most mining operations are increasing the amount of water recirculated on site. Froth flotation is a separation process that takes advantage of the physicochemical surface properties of various minerals, and it is sensitive to environmental and operational conditions. The quality of water is very important and water recycling results in significant changes to water chemistry. These changes to the water chemistry can be detrimental to flotation performance due to the accumulations of ions, reagents and other species which may have adverse effects on the pulp and froth phase phenomena. Froth stability is an important flotation performance parameter that is often quantified using dynamic froth stability and water recoveries. This study aims to investigate the behaviour of platinum group metal (PGM) ore under simulated long water recycles using a Denver flotation cell. The insights from this paper demonstrated that an increasing process water recycles compromises the stability of the froth, resulting in decreased mass pull and water recoveries. As a result, the 3E PGM recoveries decrease with improved grades. This paper will contribute to sustainable operations in concentrating plants.

Keywords: Water recirculation, 3E PGM, Water quality, Flotation performance, Pulp chemistry.

PGM Ore flotation under degrading water qualities

M.F. Moya[1,2], T. Koadibane[1,2], M. Safari[2,3], M. Manono[1], K.C. Corin[1], L. October[3]
[1]University of Cape Town, South Africa
[2]Mintek, South Africa
[3]The University of the Witwatersrand, South Africa

The mining industry is forced to have water management strategies for their operations as a response measure to the challenges with the availability of freshwater resources. It has been reported that the mining industry is one of the largest contributors to the discharge of contaminated water to the environment. To reduce this discharge, most mining operations are increasing the amount of water recirculated on site. Froth flotation is a separation process that takes advantage of the physicochemical surface properties of various minerals, and it is sensitive to environmental and operational conditions. The quality of water is very important and water recycling results in significant changes to water chemistry. These changes to the water chemistry can be detrimental to flotation performance due to the accumulations of ions, reagents and other species which may have adverse effects on the pulp and froth phase phenomena. Froth stability is an important flotation performance parameter that is often quantified using dynamic froth stability and water recoveries. This paper aims to investigate the behaviour of Cu-Ni-PGM ore under degrading water qualities using a batch flotation cell. The insights from this paper demonstrated that increasing the stability of the froth results in improvement in water and solids recoveries, and an improvement in valuable mineral recoveries. This paper will contribute to sustainable operations within concentrating plants.

Keywords: Frother, PGM ore, Water quality, Flotation performance, Pulp chemistry.

Mthulisi Moya

Process Engineer
Mintek

Mthulisi Floyd Moya is a dynamic and results-oriented Chemical Engineer with a strong academic and professional background in minerals processing. He currently serves as a Process Engineer at Mintek, one of South Africa's leading research and technology organizations, where he contributes to the advancement of flotation processes for the recovery of platinum group metals (PGMs) and other valuable minerals. Floyd obtained his BSc (Eng) in Chemical Engineering from the University of Cape Town (UCT) in 2021 and is currently pursuing his MSc (Eng) in Chemical Engineering at the same institution. His master's research focuses on water quality in flotation and its impact on the on-flotation performance. His work is motivated by the increasing need for sustainable water use in minerals processing plants and the complex impact of water recirculation on froth stability and selectivity. His research interests contribute to a better understanding of how process water chemistry influences metallurgical performance. The insights gained from his research have potential applications in the design and optimization of flotation circuits that operate with limited water resources which is an increasingly important consideration for South African concentrators and global PGM operations. Floyd's broader interests lie in the interface between metallurgical test work and plant application. He is passionate about translating laboratory insights into practical solutions that support sustainable mining and beneficiation. His exposure to various commodities including base metals, PGMs, and industrial minerals has deepened his understanding of the different flotation challenges faced by the mining industry. Floyd continues to engage with industry forums such as the SAIMM to stay informed about emerging technologies and to share his research with fellow professionals. His participation in the 2025 SAIMM PGM Conference reflects his ongoing commitment to innovation, sustainability, and excellence in the minerals processing sector.

Revisiting the role of pH modifer and process water ions in platreef Cu-Ni-PGM ore flotation: What's the matter with choosing a pH modifier?

M.S. Manono
University of Cape Town, South Africa

In sulfide mineral flotation, pH control is traditionally regarded as a fundamental operating parameter, commonly adjusted using inorganic pH modifiers such as lime, caustic soda, or soda ash – there exist arguments in the literature that some collectors also exhibit pH modification effects owing to residual components from the collector synthesis processes. However, in the context of water recirculation, ion build-up, the choice of pH modifier and the resulting electrolyte interactions and speciation, may introduce not only a desired pH shift but also a distinct suite of inorganic electrolytes into flotation. These inorganic electrolytes whether calcium from lime or sodium from caustic soda can influence the electrochemical properties of mineral surfaces in the pulp phase, particularly under high ionic strength conditions typical of modern mineral concentrators with closed water circuits. This paper investigates whether the type of alkaline pH modifier affects flotation performance for a selected Platreef Cu-Ni-PGM ore, beyond its role in achieving target pH. Batch flotation experiments were conducted at the natural pH of the slurry (~pH 9), pH 11 and pH 12 in synthetic process water with an ionic strength typical of concentrator process water (0.0241 mol.dm^{-3}) and in synthetic process water of a higher-than-normal process water ionic strength (0.241 mol.dm^{-3}). Alkaline pH modifiers in the form of slaked lime ($Ca(OH)_2$) and caustic soda (NaOH) were used for pH adjustments. This work explored how these chemically distinct modifiers affect sulfide mineral recovery and selectivity in a complex sulfidic Cu-Ni-PGM ore from the Platreef. The broader motivation arises from previous work highlighting specific ion effects and ionic strength variations in synthetic process waters and their influence on flotation chemistry. By isolating the role of the pH modifier as an electrolyte contributor, this research aims to deepen our understanding of reagent-mineral-water interactions. Findings from this work are expected to inform both fundamental flotation research and operational strategies for optimising reagent selection in recirculated process water environments where pH modification is a key operating factor.

Keywords: Divalent ions, entrained gangue, floatable gangue, ionic strength, water quality

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Malibongwe Manono is an Associate Professor in the Department of Chemical Engineering and the Deputy Dean of Undergraduate Studies in the Faculty of Engineering and the Built Environment at the University of Cape Town. He holds a PhD in Chemical Engineering specialising in Minerals Processing. His research interests are in the areas of froth flotation, water within flotation, dewatering of flotation products and value recovery from minerals and metallurgical processing waste. He has supervised many final-year Chemical Engineering projects, 13 MSc(Eng) students and 2 PhD to completion. He is currently supervising 15 MSc(Eng) students and 1 PhD candidate. His publication record boasts over 20 articles in globally recognised journals and significant participation in international and local conferences. He also stands as a reviewer for esteemed journals in his research field and has lent his expertise to conference organising committees for international conferences as a scientific committee member.

Beyond recovery: Rethinking reagent strategies for sustainable middle group ore processing

P.C. Siwela, M.M. Ramakokovhu, M.L. Teffo
Tshwane University of Technology, South Africa

The economic extraction of platinum group metals from Middle Group ores has historically been deemed challenging. Yet, due to the depletion of more conventional ore sources like UG2 and Merensky, these ores are increasingly processed in metallurgical plants. However, reagent addition strategies, originally developed for UG2 and Merensky ores, are often directly applied to Middle Group ores without full consideration of their unique mineralogical properties. This study addresses the resulting knowledge gap surrounding xanthate and depressant interactions within Middle Group ore processing.

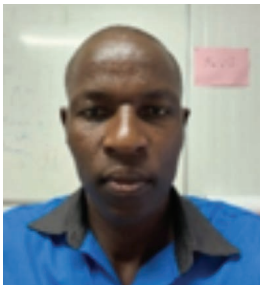
This research, titled "Beyond recovery: rethinking reagent strategies for sustainable middle group ore processing", critically examines and aims to improve beneficiation strategies for Platinum Group Metals from Middle Group chromitite. It acknowledges the environmental challenges and limited selectivity associated with traditional xanthate-based flotation schemes. The primary objective was to optimize a xanthate-based reagent suite to achieve enhanced valuable mineral grades and recoveries comparable to established industry benchmarks.

The methodology involved systematic batch flotation tests in a Denver flotation cell. While the frother (Betachem 436 at 25 g/t) and activator (copper sulfate at 80g/t) dosages were kept constant, the depressant and collector dosages were varied to investigate and optimize their impact on separation. PGM content was determined using fire assay coupled with Inductively Coupled Plasma-Optical Emission Spectrometry, and bulk chemistry and modal mineralogy were analyzed by X-ray Fluorescence and X-ray Diffraction, respectively. Ore samples, sourced from the Bushveld Complex in South Africa, were blended chromitite, and a milling curve analysis determined that 40 minutes of grinding achieved an 80% passing 75 microns particle size.

Key findings from the chemical dosage optimization revealed that the highest metal recovery of 79.06% was achieved with a combination of 200 g/t SIBX and 150 g/t CMC, underscoring the crucial role of both SIBX and CMC dosages in maximizing recovery. Variations in CMC dosages significantly altered recovery for fixed SIBX concentrations, indicating an optimal range for each reagent. Mineralogical analysis of the feed demonstrated a dominance of Chromite (74.4%), followed by Pyroxene (15.9%) and Plagioclase (8.6%). Notably, common sulfide minerals, often PGM hosts, were absent, suggesting PGMs are associated with chromite or other silicate minerals rather than sulfides. The flotation process dramatically enriched Pyroxene in the concentrate, increasing its proportion from 15.9% in the feed to 73.4%, while effectively rejecting a significant portion of Chromite from the concentrate (from 74.4% in feed to 19.3%) to the tailings (56.1%). Amphibole also showed enrichment in the concentrate (from 0.1% to 2.6%), contributing to gangue. The study further illustrated the classic grade-recovery trade-off, where increasing cumulative recovery (up to 75.59%) typically led to a decrease in concentrate grade.

In conclusion, this research successfully optimized a xanthate-based reagent suite for the froth flotation of Middle Group chromitite, achieving significant metal recovery. The process demonstrated high selectivity of Pyroxene while effectively rejecting Chromite, highlighting the challenge of reduced concentrate grade for PGM extraction. The findings contribute valuable insights into developing more sustainable and efficient beneficiation routes for PGM recovery from complex ore types, emphasizing the importance of tailored reagent strategies and understanding mineralogical associations in optimizing metallurgical performance.

Keywords: froth flotation, reagent strategies, Middle group ore, xanthate, CMC, PGM recovery.



Phumlani Siwela

Process Superintendent
Minopex

I am a seasoned metallurgical environmental professional with 16 years of experience in the mining industry. Starting as a student, I demonstrated unwavering dedication and perseverance, rising through the ranks to attain the esteemed position of Superintendent.

Throughout my illustrious career, I have gained extensive expertise in various commodities, including Platinum Group Metals (PGM), chrome, and coal. This diverse experience has equipped me with a unique understanding of the complexities and challenges associated with different mining operations.

A holder of two master's degrees, I have earned an Mtech in Metallurgical Engineering and an MBA. This exceptional academic background has provided me with a strong foundation in both the technical and business aspects of the industry.

As a respected leader, I continue to drive innovation and excellence in metallurgical environmental management, leveraging my expertise to optimize processes, ensure sustainability, and foster growth in the mining sector.

Optimising blend ratios, grinds and reagent schemes to recover PGMs from LG reef spiral tailings

T.L Moodley[1,2], I Govender[1,2,3], S. Pikinini[1], J. Sehata[1], J. Tshilongo[1], M Raedani[4]
[1]Mintek, South Africa
[2]University of Kwazulu-Natal, South Africa
[3]University of Cape Town, South Africa
[4]Dwarsrivier Chrome Mine, South Africa

In the face of dwindling Merensky ore reserves in the early 1990s, Mintek developed the MF2 flotation circuit to economically recover platinum group metals (PGMs) from the shallow UG-2 chromitite reef. By aligning the primary and secondary grind to the PGM liberation kinetics, excessive fine chromite generation was avoided, and thus one could consistently produce high-grade concentrates (>200 g/t PGMs) with low chrome content (<3% Cr_2O_3)—well within smelter tolerances. This, coupled with UG-2's low-cost open-pit mining, made it particularly attractive to investors and mining houses alike. As a result, deeper lying reefs like MG and LG, with lower PGM grades and complex mineralogy, were primarily mined only for chromite using density-based separation processes (like spirals), whose waste tailings are best classified as secondary PGM resources.

Today, with global PGM demand rising and high grade UG-2 reserves rapidly diminishing, the industry must revisit these MG and LG tailings. Mineralogical analysis reveals several challenges: MG tailings feature PGMs locked within silicate matrices, while LG tailings contain fine chromitite fragments, and are hosted within non-floating laurite (RuS) grains, each presenting liberation and gangue issues. Smelter constraints still demand concentrates below 3% Cr_2O_3, requiring solutions that consider both PGM recovery and chrome entrainment.

To develop a solution, two LG chrome spiral tailings samples were obtained from a large chrome mine: Sample A (+425–106 µm) and Sample B (−106 µm). Initial assays showed Sample B contained higher PGM grades but also higher Cr_2O_3. As such, different blends of flotation feeds were evaluated using ratios of 90:10 (C1) and 80:20 (C2) of Sample A to Sample B, targeting the coarse fraction's lower chrome content while recovering valuable PGMs from the fines.
This work proposes a practical route for mining houses to unlock additional PGM value from LG ore spiral tailings. By optimising blending ratios and reagent suites, it is possible to meet smelter chrome and PGM grade thresholds whilst still obtaining economically-viable PGM recoveries.

The full paper will be published in the SAIMM Journal

Dr Taswald Llewelyn Moodley
Principal Engineer
Mintek

Dr. Taswald Llewelyn Moodley is a Principal Engineer at Mintek and an Honorary Research Fellow at the University of KwaZulu-Natal. With nearly 15 years of research and development experience, his work focuses on the simulation of minerals processing systems (using DEM and SPH) and their experimental validation (via PEPT). Dr. Moodley is a registered Professional Engineer (ECSA) and an active member of the Southern African Institute for Mining and Metallurgy (SAIMM).

Understanding the nature of challenges posed in PGM recovery from secondary tailings resources

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[1]University of Cape Town, South Africa
[2]Sylvania Platinum, South Africa

The retreatment of secondary tailings for platinum group metals (PGMs) recovery presents a range of potential challenges, which vary depending on the nature of the original ore and the type of pretreatment it was subjected to. These challenges include the prevalence of ultrafine particles which promote slimes coatings on valuable minerals, hinder bubble-particle attachment, increase pulp viscosity and lead to higher gangue entrainment; surface oxidation of minerals, which alters their floatability; and the presence of deleterious gangue minerals and residual PGM species that are inherently difficult to recover by flotation.

This study compares the batch flotation performance across a range of tailings samples from the Eastern and Western limbs of the Bushveld Complex. Complementary mineralogical analysis was conducted to gain deeper insights into mineral behaviour. The paper evaluates these findings to identify the key factors contributing to poor PGM performance.

Keywords: platinum group minerals, tailings reprocessing, sodium metasilicate, ultrafine particles

The full paper will be published in the SAIMM Journal

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Belinda McFadzean is an Associate Professor in the Centre for Minerals Research, which is a multidisciplinary research, teaching and consulting Centre at the University of Cape Town, South Africa. Her research focusses on the flotation process and ranges from fundamental molecular surface interactions to plant-scale optimisation techniques. She manages large research projects, supervises and teaches postgraduate students, and is a consultant to the mineral processing industry.

Transforming PGM tailings into valuable resources for a cleaner world

R.A. Madiba, B.F. Mphahlele, O. Muswadz, N.J. Shackleton
AECI Mining Chemicals, South Africa

Ongoing research in tailings retreatment projects presents an opportunity to further extract valuable minerals, specifically platinum group elements (PGEs) and base metal sulfides (BMS), from materials previously considered waste. Mine tailings represent untapped secondary sources of these critical minerals. As the world transitions towards a cleaner and more decarbonised future, PGMs have played a crucial role in mitigating vehicle exhaust emissions through catalytic converters. Additionally, new applications for PGMs, such as in fuel cells, are emerging. These fuel cells generate cleaner hydrogen, which can power trucks, trains, buses, factories, and more in various regions. South Africa, holding approximately 80% of the world's PGM reserves, stands to benefit significantly from this shift. The demand for PGMs is projected to rise to 350,000 ounces by 2030. This study aims to explore how flotation reagents can be utilised to optimise the recovery of PGMs and BMS from tailings, ensuring maximum output and contributing to a sustainable future.

Keywords: PGM tailings, collectors, depressants, frothers

Genfroth 200: An economical frother with enhanced metallurgical synergy in UG2 flotation

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AECI Mining Chemicals, South Africa

Genfroth 200 was developed as a cost-effective alternative to traditional PPG200-based frothers used in platinum group metals (PGM) flotation. Laboratory tests on a UG2 concentrator in the Western Bushveld showed that, beyond its economic advantages, Genfroth 200 provides synergistic improvements when paired with xanthate collectors. It achieved a higher 4E PGM concentrate grade (131 g/t) and recovery (87%) compared to the standard frother (115 g/t, 83%), while also reducing Cr_2O_3 deportment to the concentrate (2.8 vs 2.9 kg/t feed), thus lowering chromite contamination. Genfroth 200 was developed as a cost-effective alternative to traditional PPG200-based frothers used in PGM flotation. Laboratory tests on a UG2 concentrator in the Western Bushveld showed that, beyond its economic advantages, Genfroth 200 provides synergistic improvements when paired with xanthate collectors. It achieved a higher 4E PGM concentrate grade (131 g/t) and recovery (87%) compared to the standard frother (115 g/t, 83%), while also reducing Cr_2O_3 deportment to the concentrate (2.8 vs 2.9 kg/t feed), thus lowering chromite contamination.

Additional investigations at another UG2 concentrator in the region confirmed that Genfroth 200 can directly replace existing frothers without sacrificing performance and that its combination with a pure-xanthate blend collector significantly improved both initial and overall PGM concentrate grades and recoveries. Initial concentrate grades increased from approximately 189 g/t to 377 g/t, while overall grades rose from about 84 g/t to 102 g/t at higher recoveries than the conventional xanthate benchmark.

These results establish Genfroth 200 not only as a cost-saving frother but also as a reagent that enhances collector–frother synergy, improves concentrate quality, and reduces chromite contamination. Plant-scale trials are recommended to confirm these laboratory findings and quantify the operational benefits.

Gift Sipho Mosia
Product and Technical Manager
AECI Mining Chemicals

Gift Sipho Mosia is a Product & Technical Manager at AECI Mining Chemicals, specialising in flotation reagents for the mining industry. With a background in metallurgy (B-Tech, Metallurgy) and a senior management development certificate from GIBS, he has over 19 years of experience in product development, plant trials, and technical-commercial strategy. Gift works closely with clients across Africa, Europe and Latin America, driving innovation in collectors, frothers, and depressants while ensuring supply chain and cost optimisation.

The impact of microbes on the flotation efficiency of Platinum Group Metals

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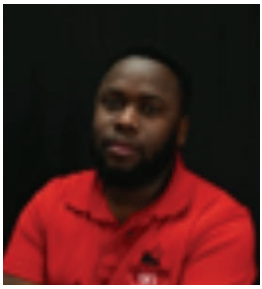
The role of microbial communities in mineral processing has gained increasing attention due to their potential impact on flotation efficiency. This paper investigates the influence of microbes and water constituents on the flotation of platinum group metals (PGMs) using UG2 Comprehensive site visits, sampling campaigns, and laboratory analyses were carried out to assess microbial presence, water chemistry, and flotation performance at a collaborative mine plant. Key flotation parameters such as reagent efficacy, mineral surface chemistry, and froth stability were evaluated. The findings indicate that microbes are introduced primarily through ore materials rather than process water, significantly altering mineral hydrophobicity and reducing flotation efficiency. UG2 ore demonstrated the highest PGM recoveries, while mixed and 'bad' ores exhibited high Cr_2O_3 contamination. Additionally, flotation tests revealed a correlation between increased mass pull and Cr_2O_3 contamination, highlighting the need for optimised flotation strategies. This paper emphasises the necessity of microbial management in flotation circuits to enhance recovery rates and reduce contamination. Microbial identification via DNA extraction shows that there is a wide range of microbes which have to be isolated and cultured for flotation experiments. Therefore, mitigation strategies, beneficiation studies, and process optimisation will be implemented to improve plant performance while promoting sustainable water usage in mineral processing.

Keywords: Microbes, Flotation Efficiency, Platinum Group Metals, Water Chemistry, Reagent Efficacy, Contamination Mitigation



Mandla Brian Chabalala

Post-Doctoral Research Fellow
Mintek

Dr Mandla Brian Chabalala studied for a BSc and BSc honours at the University of Limpopo. He graduated with his MSc in nanoscience (chemistry) in 2016 from UJ and his PhD in Chemistry from UNISA in 2022. Dr Chabalala worked as an operator, senior operator and technician at SGS South Africa from 2020 to 2022. He was a post-doc fellow at UNISA and is currently a postdoctoral research fellow at MINTEK in the mineral processing division, specialising in water treatment and quality for flotation processes. He has dedicated his career to developing innovative solutions for environmental remediation and flotation process optimisation. Their research aims to tackle critical issues of water scarcity, mineral processing, and sustainable energy.

His work involves the removal of harmful pollutants from water. These advancements contribute to making water purification processes more efficient and sustainable. He has collaborated with interdisciplinary teams, emphasising the importance of a holistic approach to solving environmental and energy problems impacting human development. At MINTEK, Dr. Chabalala continues to push the boundaries of environmental science, seeking to bridge the gap between research and real-world applications. The dedication to advancing science and technology aligns with global sustainability goals, aiming to ensure access to clean and safe water for all. He is committed to contributing to improved environmental and public health through innovative research and practical solutions for the benefit of humankind. He further carries out research in mineral processing, particularly flotation processes. In this work, he leads and oversees commercial and research projects aimed at developing and modifying flowsheets, developing flotation recipes, optimising mineral recovery without compromising grade, as well as the effect of water recirculation and microbes in PGM flotation, among others. His academic and industrial experience and research exposure, as well as chemistry background, make him one of the key players in the mineral processing and chemistry research and development field.

Flotation of MG chromite tailing from the Western Limb of the Bushveld Complex

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The flotation of Middle Group chromite ore dumps from the western limb of the Bushveld Complex presents a distinct challenge due to their fine particle size and complex mineralogy. The mineralogical analyses shows that the tailings dumps contained a high amount of ultra fines (43% less than 25 um) which could affect its processing efficiency and final product quality during froth flotation. The PGMs in the tailings dumps also showed low association with base metal sulfide,s making them difficult to recover with regular xanthate collector. This paper investigates the effect of a Mach Reactor, dispersant addition and hydroxamate with the aim of optimising the recovery of platinum group metals (PGMs) from the dumps. To achieve this, the sample was pre-treated on a Mach Reactor at different passes, followed by batch flotation tests at a pH of 9.5 using a Denver D12 flotation cell. The concentrates were collected at 1,3,7,11,20 and 40-minute intervals in order to understand the stage-wise recovery of PGMs. Flotation results indicate that it is possible to achieve a recovery of around 56.5% PGMs by pre-treating the ore with a Mach Reactor prior to flotation. The stage wise recovery of the PGMs in the dumps suggests that most PGMs are slow floating.

Keywords: PGMs, Fine Flotation, Mach Reactor, MG.

Thabiso Elphus Nyaka
Engineer
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I am Thabiso Elphus Nyaka, a flotation Engineer at Mintek. I am current student for a BSc hons in applied science metallurgy at University of Pretoria. I hold a Btech in metallurgical engineering and a BSc hons in Engineering and Technology Management. I started my career at Optimum Coal as a bursar, which is where I also did my in-service training in 2011. I joined Tharisa Minerals in 2015 as a Graduate/Junior metallurgist. In 2018, I Joined Pan African Resources as a Metallurgical Foreman and current working as an Engineer in the mineral processing division at Mintek.

Effects of pyrite on mill pulp characteristics and flotation performance

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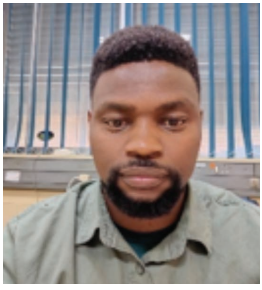
Base metal sulfides play a crucial role in platinum group element (PGE) ore metallurgy, serving as host rocks and occasionally as economically valuable minerals. In the Bushveld Complex and Great Dyke, PGE ores are frequently associated with pyrrhotite, pentlandite, chalcopyrite, and pyrite as a minor phase. Notably, in some Ni-Cu-PGE deposits, pyrite can host significant PGE concentrations, especially Pt and Rh. While most base metal sulfides are economically important, pyrite is often considered of low value and targeted for rejection during processing. However, its natural floatability presents challenges in separation. Additionally, the high rest potential of pyrite can promote galvanic interactions leading to oxidation of other minerals and Fe-bearing media, impacting mineral recovery. As an Fe-bearing mineral, pyrite dissolution can produce problematic hydroxide and oxyhydroxide species, which may also form when using mild or forged steel grinding media, further complicating flotation. Understanding the reactivity of pyrite during milling and flotation is essential for effective rejection. This paper employs a synthetic ore with pyrite as the sole sulfide mineral, and synthetic plant water containing gangue ions common to PGE operations to examine the chemical condition of the pulp phase resulting from milling under various conditions: different pH levels, milling media (forged steel vs ceramic), and water types (deionised vs synthetic). The impact on downstream flotation performance is assessed through solids-water recovery, grade, Eh, zeta potential, residual SIBX, and X-ray photoelectron spectroscopy data. These insights aim to enhance understanding of pyrite behaviour in mineral processing, informing strategies for its optimal removal.

Keywords: Pyrite, Water Recycling, Platinum Group Elements, Base Metal Sulfides, Milling Media



Sancho Nkosilathi Nyoni

Engineer
University of Cape Town | Mintek

Sancho is a minerals processing engineer and researcher committed to promoting innovation in the mining industry. His primary areas of interest include sustainable mineral beneficiation, optimisation of grinding media, flotation chemistry and water recycling. His research encompasses various commodities such as base, strategic, and critical metals, as well as industrial minerals and coal. Several of his papers are published in reputable journals like Minerals Engineering and Physicochemical Problems of Mineral Processing. He is a 2024 NRF Award recipient for Next-Generation Researchers and an Associate Member of the Southern African Institute of Mining and Metallurgy (SAIMM). Additionally, he has participated in the Young Professionals Council of the SAIMM and served on the Western Cape SAIMM Committee, organising activities, programmes, and events to foster scientific engagement and assist young professionals in developing the skills and networks crucial for success in mining and metallurgy.

The flocculation and coagulation of PGM ore flotation tailings under degrading water qualities

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There are mainly two products that are yielded from the froth flotation process, namely, the concentrate and the tailing streams. These products undergo dewatering processes of coagulation-flocculation-sedimentation for water recovery and thickening. The recovered water is recycled back into froth flotation as process water. The recycled process water is usually highly concentrated in polyvalent inorganic electrolytes which may affect both froth flotation and dewatering processes. Coagulation and flocculation are well established processes in water treatment and are also applied in various industries such as in pharmaceuticals manufacturing. In mining, it is applied in water treatment and tailings management. The Jar test method is widely used in laboratories for flocculation and coagulation experiments aimed at optimising coagulation-flocculation-sedimentation. This study is aimed at evaluating the effectiveness of the settling behaviour of tailings and the turbidity of the supernatant liquid under different water qualities. The results indicated that degrading water quality has an influence on the thickening performance. This is due to the interactions of the ions present in the water, the tailing slurry and the chemistry of the flocculants. This study highlights the effect of water quality and its impact on flocculation performance of PGM tailings.

Keywords: Coagulants, Flocculants, Jar tests, PGM tailings, Process water chemistry, Recycled process water, Settling, Turbidity, Water recovery

Tsholofelo Koadibane

Senior Engineer
Mintek

Mrs. Tsholofelo Koadibane, born and bred in Makapanstad village in the Northwest province, is a devoted wife, proud mother of three, and a sister and mentor to many. She is a seasoned Senior Metallurgical Engineer with over 15 years of experience in mineral processing.

She completed her matric in Her professional journey began in 2006 when she joined Impala Platinum in Rustenburg as an in-service trainee after completing her second year at the Tshwane University of Technology. She completed her National Diploma in Engineering Metallurgy in 2008 and went on to earn her B.Tech degree in 2009, during which she also served as a tutor, demonstrating her early passion for mentorship and knowledge sharing.

Following graduation, Tsholofelo was selected for the Joint Initiative on Priority Skills Acquisition (JIPSA), a government-led programme, and was placed at Anglo Platinum Refineries (Rustenburg) for six months as a graduate trainee.

In pursuit of deeper expertise, she joined the Minerals Processing Division at Mintek as an intern through the DST/NRF internship programme. Her dedication and performance earned her a bursary to further her studies at the University of Pretoria, where she obtained her B.Sc. (Hons) in Engineering Metallurgy in 2013, She later returned to Mintek in 2014, where she continues to contribute her knowledge and leadership to the advancement of mineral technologies. She completed the MSc. Project Management from the University of Pretoria in 2020.

Tsholofelo's career reflects her unwavering commitment to professional growth, education, and empowering others — both in the workplace and in her broader community.
She is currently employed at Mintek's Minerals Processing Division, where she works on both commercial and research projects across various commodities., she brings a proven track record in mineral processing and excels at collaborating with both local and international clients. She is a candidate for MSc. (Eng) in chemical engineering at the University of Cape Town.

Tsholofelo is skilled in project management, proposal development, and technical reporting, and is known for her adaptability, strong communication, and ability to thrive in both team settings and independent roles. She is deeply passionate about delivering high-impact results and driving innovation in the metallurgical field while mentoring students and junior colleagues. Besides her professional career, she is passionate about fitness and likes to exercise and participate in walks, races, hiking, bootcamps as well as aerobics.

Comparison of technical operating flexibility and operating cost performance at selected underground platinum mines for long-term operational viability

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[1]Anglo-American Platinum Joint Venture Operations (now Valterra Platinum), South Africa
[2]University of the Witwatersrand, South Africa

Technical operating flexibility is a performance metric that is measured using a Flexibility Index (FI). Its analysis is undertaken in support of long-term operational viability through consideration of practices aimed at improving operating cost performance. This metric is important particularly in an ever-changing business operating environment. For example, the business operating environment for platinum mining has experienced relatively depressed platinum prices post-2008, leading to some platinum group metal (PGM) mines being downsized or placed on '*care-and-maintenance*'. Anglo-American Platinum (now Valterra Platinum) uses 'Immediately Mineable Stopes (IMS)' as a proxy for FI. IMS is extended to Immediately Available or $FI_{-extended}$. This paper uses selected underground PGM mines to demonstrate that technical operating flexibility affects operating cost performance. The influence of type of mining method on technical operating flexibility is also evaluated. The paper recommends some practices for improving levels of technical operating flexibility to improve operating cost performance for long-term operational viability of PGM mines.

Lefu J. Mohloki

Lecturer
School of Mining Engineering, University of the Witwatersrand

Lefu Mohloki is an experienced mining engineer who holds BSc (Mining Engineering) and MSc (Mining Engineering) degree both obtained from the University of the Witwatersrand, Johannesburg, South Africa. He also holds an LLB degree obtained from the University of South Africa (UNISA). He also holds a Mine Managers Certificate of Competency (MMC) and is a member of the Southern African Institute of Mining and Metallurgy (SAIMM). He has over 30 years of multi-commodity mining industry experience in EPCM Project Management, Supply Chain Management, Contract Management, Mine Design and Planning, Mining Consulting, Mining Project Execution, Production Management and more recently in academia as a lecturer. He previously presented a technical paper at the SAIMM 4th International Platinum Conference in 2010.

Optimisation of proportional influence of mining and processing costs on the production of an open pit mine

R.G. Thage, F.K. Mulenga
University of South Africa, South Africa

It is well-established that mining and processing costs are critical to the actual production planning in both open pit and underground mining. Yet, little attention is being given to ensuring a sensible overlap between the two costs and the production plan. The proposed study presents a sensitivity analysis of mining and processing costs on mine production planning. To this end, the NewMan1 block model was utilised concurrently with the SimSched Direct Block Scheduling computer code to achieve the objectives of the study. The results indicate strong potential for improving net present value (NPV) through cut-off grade optimisation. The break-even cut-off grade supports a longer mine life and sustained metal output, particularly during the early years of production. However, increases in processing costs were shown to raise the cut-off grade and reduce metal output, while higher mining costs had a comparatively smaller impact on NPV. The analysis further revealed that when the orebody contains high-grade or high-value by-products, production planning must account for their influence on overall plant performance to prevent excessive dilution. Therefore, conducting sensitivity analyses on both mining and processing costs is essential to ensure that low-grade, uneconomic zones of the orebody are not mined.

Keywords: net present value (NPV), comminution costs, cut-off grade, pit optimisation, mining costs, processing costs

Rorisang Thage
Lecturer
University of South Africa

Rorisang Gomolemo Thage is a passionate Mine Surveying Lecturer at the University of South Africa, dedicated to advancing excellence in mining education and research. She is currently pursuing a PhD in Engineering, Science, and Technology, focusing on optimizing mine planning through advanced algorithms. Recognized among the Mail & Guardian Top 200 Young South Africans (2023), Rorisang has received multiple awards for her leadership and innovation in the mining sector. Her work promotes the integration of technology in mine planning and the empowerment of women in engineering, reflecting her commitment to shaping the future of sustainable mining education.

The impact of data quality on budget development and reporting in mining operations

Z. Mqoqi[1], H.P.R. Joubert[1,2], J.H. Marais[2]
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[2]North-West University, South Africa

The mining sector uses budgets for operational effectiveness and strategic planning of financial and material resources. Additionally, budgets support informed decision-making by anticipating growth, cost reduction opportunities, and tracking efficiency programs. The integrity of these budgets relies on the quality of input data. Poor data quality undermines budget development, compromising the integrity of financial reporting, and may result in misguided decision-making. This, in turn, can result in inefficient resource allocation and significant financial losses.

This paper examined the influence of data quality on budget development and reporting accuracy within the platinum group metals mining sector. Using the International Standardization Organization (ISO) 25012 framework, seven key dimensions of data quality, accuracy, completeness, consistency, credibility, traceability, and availability, were assessed through a structured case study of ten mining operations.

The case study highlighted accuracy, completeness, and currentness as the most critical data quality challenges affecting budgeting outcomes. Inaccurate or incomplete data, alongside outdated information, led to significant budget deviations, inaccurate reporting, and poor cost control. The proposed 'Data Quality Toolbox', comprising subsystem-level analysis, growth and reduction reviews, and real-time reporting, offered a practical pathway to strengthen budgeting processes. The paper underscores the need for robust data governance, subsystem-level analysis, and real-time reporting to enhance data quality and improve budget reliability, supporting better decision-making and operational alignment in mining.

Keywords. Data quality, budget development, Platinum Group Metals (PGM), Reporting integrity, mining, reporting

Zilungile Mqoqi

Engineer
ETA Operations

Zilungile holds a master's degree in chemical engineering from the Cape Peninsula University of Technology, where her research focused on the treatment of municipal wastewater. Since joining ETA Operations in January 2023, she has held roles in both water management and utility management, supporting operational performance and regulatory compliance across a range of client sites. In her role in water management, she was responsible for conducting on-site audits, compiling water balances and layouts, monitoring consumption for compliance with water use licenses, and investigating surface water issues. Her work involved close collaboration with engineers, environmental officers, and foremen to develop practical, data-driven solutions to water-related challenges.

She later joined the utility management team, where her responsibilities included compiling digital utility reports, and managing a proprietary meter reading application. She oversaw the application's configuration, supported client integration, conducted user training, developed reporting processes, and coordinated with developers to improve functionality.

In her current position as Measurement and Verification Engineer, she is responsible for compiling key performance reports, including intensity reports, energy and cost savings, compiling budgets, and performing ad-hoc reporting to inform strategic decisions.

Optimising PGM value chains through embracing Lean Six Sigma Principles

T. Chagwedera, M. Naidoo
Hatch, South Africa

The global platinum group metals (PGM) industry faces mounting pressures from volatile commodity prices, escalating operational costs, and stringent environmental regulations. As demand for PGMs grows, driven by their critical role in green technologies such as hydrogen fuel cells and catalytic converters, mining companies must strategically position themselves to remain competitive while meeting sustainability goals. This presentation explores the application of integrated lean methodologies to optimise the PGM value chain, from extraction to refining, offering a pathway to enhance operational efficiency, reduce costs, and align with environmental, social, and governance imperatives.

Lean principles, rooted in waste elimination and continuous improvement, provide a robust framework for addressing the PGM industry's operational challenges. By integrating lean strategies across mining, processing, and supply chain operations, companies can achieve significant improvements in productivity and resource utilisation. In mining, lean techniques such as value stream mapping and just-in-time scheduling can minimise downtime, optimise equipment usage, and reduce fuel consumption in mechanised operations. In processing, lean approaches streamline beneficiation and smelting processes, improving PGM recovery rates while lowering energy and water usage—a critical factor given the industry's high energy intensity. Supply chain optimisation, through lean inventory management and logistics, further reduces costs and enhances responsiveness to global market demands

Strategically, lean optimisation enhances competitiveness by enabling PGM producers to navigate market volatility and supply chain disruptions while meeting the growing demand for responsibly sourced metals. By integrating lean principles with emerging digital tools, such as the internet of things and data analytics, companies can further amplify efficiency gains, creating a resilient and agile value chain. This approach aligns with the SAIMM PGM Conference's focus on operational excellence and innovation, offering actionable insights for industry practitioners, technical experts, and policymakers. In conclusion, this presentation advocates for the adoption of integrated lean strategies as a cornerstone for strategic positioning in the PGM industry. By driving operational efficiency and sustainability, lean methodologies empower companies to thrive in a dynamic global market, ensuring long-term viability and leadership in the energy transition. Recommendations will include frameworks for lean implementation and collaboration with technology partners to maximise impact, positioning the PGM sector for a sustainable and competitive future.

Case study: Unlocking maintenance efficiency and supply chain resilience in mining through digital integration and spare parts optimization

M. Joubert
HybridFuzion, South Africa

In capital-intensive mining operations, where uptime of heavy mining equipment (HME) directly impacts production and profitability, the availability of critical and non-critical spare parts is non-negotiable. However, one of the world's largest mining multinationals faced severe operational inefficiencies due to a fragmented interface between its supply chain and maintenance functions. Chronic shortages of spare parts, coupled with paper-based goods receipt processing led to missed production targets, prolonged equipment downtime, and reactive procurement practices. HybridFuzion was engaged to lead a supply chain transformation aimed at improving material flow visibility, spares availability, and digital traceability across multiple mining complexes. We initiated the project by designing a fit-for-purpose material flow network to reduce chaos and variability in the movement of spare parts. Historically, poor planning, siloed systems, and inconsistent staging practices led to bottlenecks, with critical HME standing idle while awaiting components. The cost of such delays extended beyond lost production – creating cascading impacts on mine planning, labour deployment, and vendor service contracts. Through a reclassification of SAP material master data and the introduction of a user-friendly mobile application, we introduced enhanced traceability across thousands of spare part SKUs, allowing site personnel and planners to locate, allocate, and stage parts more effectively. The mobile-application digitised the entire goods receipt process which led to a 1500% increase in process capability and a 96% increase in same-day goods receipt processing. By relying on our SAP S/4 Hana, SAP EWM, SAP Business by Design and SAP Fiori expertise we implemented a SAP-integrated kitting and staging process – aligned with Work Orders –which harmonised the interaction between supply chain planners and maintenance teams. A centralised kitting hub enabled proactive multi-week maintenance planning while real-time dashboards provided operations teams with a dynamic view of spares readiness, stock-outs, and staging progress.

The results were significant:

- $8.3 million reduction in sales expenditure;
- 90% increase in spares velocity and availability for low-value, high-volume items;
- 40% improvement in material flow visibility;
- 30% reduction in vendor-vehicle congestion on-site;
- Introduction of automated goods returns processes;
- 60% reduction in manual expediting efforts;
- 80% reduction in process variability.

This integration allowed the business to shift from reactive firefighting to predictive, planned maintenance – with improved uptime, reduced operational risk, and far greater cost control.
This supply chain transformation addressed two of the most persistent challenges in mining supply chain operations: the availability of spares and the traceability of goods movement. For supply chain professionals in mining, this case underscores the strategic role of digital integration, data visibility, and process standardisation in driving uptime, cost-efficiency, and resilience in complex mining ecosystems.

Melanie Joubert

Marketing and Sales Manager
HybridFuzion

Melanie Joubert brings over a decade of proven expertise spanning marketing, project management, and operations. Her career includes extensive experience in higher education, where she lectured business management, leadership, and marketing modules up to Honours level across various universities. She also successfully managed and launched multiple university qualifications, demonstrating strong capabilities in programme development and academic leadership. In her role at HybridFuzion, Melanie has partnered with supply chain clients to design and implement tailored solutions that enhance efficiency, streamline processes, and strengthen operational performance. Her unique blend of strategic insight and practical execution enables her to deliver measurable, high-impact results across diverse business environments. With a background that combines strategic planning, teaching, and hands-on delivery, Melanie is recognised as a dynamic professional who drives sustainable outcomes and adds value at both operational and strategic levels.

Improving compressed air network efficiency in South African PGM mines through continual monitoring and reporting

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[2]North-West University, South Africa

The South African platinum group metals (PGM) mining industry faces considerable operational costs, with compressed air networks' annual costs accounting for up to 35% of total electricity consumption. Amidst escalating electricity tariffs and volatile commodity prices, enhancing energy efficiency has become critical for economic sustainability. This study addresses the prevalent issues of mismanagement and inefficient use of compressed air on the demand side, such as leakages and unauthorized use for ventilation. While previous research has identified these inefficiencies, a gap exists in the continual monitoring and reporting of network performance to drive sustained improvements.

This paper presents a practical solution developed and applied within a major South African PGM mining group. The methodology focuses on a continual monitoring and reporting framework to improve demand side management. The implementation of this solution has demonstrated significant financial and energy-saving potential. Key findings from case studies include 1) the mitigation of R150,000 in costs over five days by rectifying a single instrumentation fault, 2) a potential annual energy saving of up to 5.6 GWh (R10.6 million) by enforcing valve closures during non-productive periods, and 3) an annual reduction of 3.7 GWh (R7.2 million) through improved underground ventilation controls. These outcomes underscore the value of a systematic, data-driven approach to managing compressed air consumption, offering a viable strategy for cost reduction and enhanced efficiency across the PGM industry.

The full paper will be published in the SAIMM Journal

Cornelius Marthinus van der Walt

Technical Engineering Specialist
ETA Operations (Pty) Ltd and North-West University

Cornelius van der Walt is a dedicated Technical Engineering Specialist at ETA Operations, where he focuses on the critical fields of energy management and compressed air optimisation within the mining industry. With five years of specialized experience, he has developed robust expertise in identifying and implementing solutions that enhance efficiency and reduce energy consumption in complex industrial environments.

At the core of his professional approach is a commitment to solving complex engineering challenges through innovation and precision. He is driven to develop robust, optimised systems that not only meet but exceed client expectations for efficiency and performance, ensuring that every solution is both effective and sustainable.

This commitment to excellence is also reflected in his academic pursuits. Cornelius holds a master's degree in mechanical engineering and is currently advancing his knowledge further as a PhD candidate. His combination of practical experience and deep theoretical understanding makes him a valuable expert in the field of industrial energy management.

Improving compressed air system efficiency using Life of Mine planning

Q.A. Bekeur[1], J.H. Marais[2], P. Burger[1]
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The South African mining industry faces increased pressure to reduce energy consumption due to national energy supply constraints and rising electricity costs. Platinum mining relies extensively on compressed air for operations such as drilling, cleaning, material transport, and refuge bays. Up to 70% of compressed air generated in deep-level mines is wasted, significantly contributing to energy inefficiency. Previous research has highlighted aspects of these inefficiencies but has rarely integrated strategic mine planning with compressed air management. Many deep mines maintain compressed air supply infrastructure in inactive areas, unnecessarily consuming energy. This study proposes using Life of Mine (LoM) planning data to systematically identify inactive mining sections, facilitating targeted audits and infrastructure adjustments. The approach bridges operational data and long-term planning, creating an innovative strategy responsive to changes in active mining locations. The method involves comparing LoM plans with updated compressed air reticulation layouts to locate inactive areas. Targeted audits and coordinated infrastructure blanking during scheduled air shutdowns mitigate air losses, verified through follow-up audits. Two case studies from South African platinum mines demonstrate this method's effectiveness. The first case achieved an 18% reduction in air consumption by blanking off seven inactive half-levels, saving R 32 million annually without affecting production. In the second case, blanking off compressed air in 12 inactive half-levels boosted compressed air pressure at active stoping faces, increasing hoisted tonnes by 13%. Integrating LoM planning data with operational audits and infrastructure changes significantly enhances energy efficiency, improves system pressure, and reduces operational costs.

Quinton Aidan Bekeur
Engineer and Master's candidate
ETA Operations and North-West University

Quinton Bekeur graduated with a bachelor's degree in mechanical engineering from the University of Pretoria in 2024. He is currently pursuing a master's degree in mechanical engineering at North-West University. During his undergraduate studies, he worked part-time as a Makerspace technician at the University of Pretoria, assisting with 3D printing, scanning, and IoT projects. Quinton gained experience in design consultation and hands-on experience in 3D printer maintenance. He completed engineering vacation work at AFMS International, where he supported the construction of BSL-3 laboratories, developed HVAC component drawings, and created airflow calculation templates. Since January 2024, Quinton has been employed by ETA Operations as an Engineer, focusing on energy efficiency in mining. Quinton's role focuses on energy management, with an emphasis on reducing compressed air wastage on mining shafts, where he analyses shaft consumption and implements initiatives to reduce energy use.

A method to reduce compressed air usage through half-level control and usage scheduling

W. Bekker[1,2], J.H. Marais[2], W.H. Sterrenberg[1,2]
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In underground platinum mining, compressed air is used for powering equipment and supporting operational processes. Due to uncontrolled usage, however, compressed air systems often result in significant energy costs and inefficiencies. This paper presents a method to reduce compressed air usage through the installation of automatic actuating valves. Valves are configured with a tailored set-point according to the compressed air demand of each operational half-level. This method involves calculating and applying specific air pressure set-points based on multiple parameters. Using these parameters enables accurate set-point development, resulting in reduced compressed air usage by eliminating oversupply. A case study involved a single half level, equipped with an automatic actuating valve, a pressure meter, and a flow meter. These instruments enabled real-time monitoring and precise regulation of compressed air. The effectiveness of this approach was assessed through continuous monitoring of air flow- and pressure data over time. Results showed an average of 10 000 m^3/h reduction during travel times, cleaning shift, and blasting shift. This translates to an average 4.7 GWh reduction per annum. This not only resulted in significant cost- and energy savings but also helped create a more stable and controlled air distribution system underground. This project demonstrated that compressed air management, achieved through data analysis and automation, is an effective method for enhancing cost-effectiveness and sustainability in the platinum group metal mining industry. The results support expanding this approach across more sections of the mine and potentially to other mining sites using similar systems.

Werner Bekker

Project Engineer and Master's candidate ETA Operations (Pty) Ltd and North-West University

Werner is a qualified Mechanical Engineer with a strong foundation in engineering design, energy management, and business development, particularly within the mining and industrial pumping sectors. With a bachelor's degree in mechanical engineering from North-West University, he has cultivated a diverse skill set through hands-on experience across project engineering, consulting, and international client relations.

Currently working as a Project Engineer at ETA Operations where he leads and supports initiatives aimed at improving operational efficiency and reducing energy costs. Werner's role involves daily data analysis on compressed air, ventilation, and refrigeration systems, conducting feasibility studies, and collaborating closely with mining personnel to implement cost-saving strategies.

Other aspects of his role at ETA Operations includes conducting power failure simulations, underground audits, and drop tests, as well as identifying inefficiencies and compressed air leakages in mining systems. Demonstrating a strong ability to communicate and build trust with stakeholders at various levels, including mine engineering managers and engineers, ensuring smooth execution and alignment on project goals.

Prior to his work in the mining sector, he served as a business development and engineering consultant at Vesconite Bearings. In this role, he provided technical and designing consulting services to clients across Europe and the United States, creating tailored solutions for bushing and bearing applications. His experience also included conducting GAP analyses and delivering client-focused presentations.
Werner thrives in high-pressure environments and enjoys solving complex problems. With a personal motto of, "Every problem has a solution," which reflects a determined mindset. Being a team-oriented professional who embrace challenges and adapts quickly to different fields, always seeking opportunities to drive improvement and innovation.

The impact of condensate on mine compressed air systems powered by clustered standalone screw compressors

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North-West University, and ETA Operations (Pty) Ltd, South Africa

Compressed air systems play an essential role in mining operations by powering critical production equipment. The energy efficiency, optimisation, and management techniques of compressed air systems have been the subject of numerous research studies, focusing on centrifugal compressor performance, energy usage, and leakage reduction. However, these studies have not established the exact effects of condensate accumulation, particularly in the clustered configurations of rotary screw compressors commonly used in platinum group metal (PGM) mining operations.

Condensate accumulation presents significant operational challenges in compressed air systems, including increased backpressure in compressed air pipes, reduced air quality supplied to critical equipment, and increased system inefficiencies. These challenges impair equipment efficacy, increase operating expenses, and reduce system reliability.

This paper aims to quantify condensate production and assess its impact on typical clustered rotary screw compressor systems commonly deployed in PGM mines. A mathematical model was developed to predict condensate generation based on compressor inlet parameters, ambient conditions, and pipeline dimensions. Empirical data from an operational PGM mine site featured a cluster of 16 rotary screw compressors; each rated at approximately 225 kW. Measurements included airflow rate, condensate volume, pipeline pressures, and ambient humidity and temperature.

The model predicted that, under normal working conditions, a 4 km compressed air pipeline would generate approximately 69,891 litres of condensate each week. According to experimental observations, empirical condensate volumes are approximately 30% less than those calculated analytically, attributed to the intrinsic variability of the underground operational environment.

Higher volumes of condensate were found to decrease airflow by as much as 15%, which is notably lower than predicted calculations. The higher condensate volumes also increased backpressure, significantly increasing compressor load and energy consumption.

These results highlight the significance of efficient condensate management systems in compressed air systems across mining operations in South Africa. Decreasing system inefficiencies and improving compressed air quality requires appropriate condensate management. The result is higher compressor performance, extended equipment life, and maximised energy usage. Ultimately, strict condensate management aligns with the environmental and operational efficiency goals underpinning modern mining processes.

Keywords: compressed air, condensate, mining operations, rotary screw compressors, efficiency, sustainability

Karabo Pshiri Petja

Mechanical Engineer
ETA Operations (Pty) Ltd & North-West University

Karabo Petja is a dynamic Mechanical Engineer with a strong foundation in mining infrastructure, energy systems optimisation, and project execution within complex mining operations. He leads teams in the planning, design, and implementation of mechanical and utility systems throughout mining operations and has more than two years of technical and managerial expertise.

At the Marula Platinum Mine (Driekop Shaft), where he is currently employed as a Project Engineer for ETA Operations and 2.9.2 Site Appointee, he has managed significant capital projects, such as the design and acquisition of an R27 million compressor house to support underground compressed air demand and the implementation of an R35 million dirty water handling system that is essential for operational continuity and environmental compliance.

Karabo's focus on sustainability and energy efficiency is a fundamental component of his strategy. Compressed air optimisation, mine water control, structural infrastructure design, and contractor management are among his areas of expertise. By implementing various compressed air initiatives, he has achieved significant reductions in energy usage, resulting in quantifiable savings in operating expenses and kilowatt-hours. He often collaborates with automation and instrumentation teams to optimise runtimes, integrate monitoring systems, and ensure the long-term reliability of plant machinery.

Currently pursuing a master's degree in mechanical engineering at North-West University, Karabo is expanding his expertise through academic research and field-based data analysis. His graduate research examines the impact of condensate accumulation in clustered rotary screw compressors—a topic with significant implications for the performance of compressed air systems in platinum group metal (PGM) mining operations.

Karabo has a strong interest in the relationship between engineering and business, and he actively participates in the technical and strategic development of engineering systems in the mining sector. He believes in continuous improvement, stakeholder collaboration, and the power of engineering to drive meaningful change in South Africa's resource sector.

Energy savings achieved through compressed air control valve control

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South Africa's energy landscape is characterised by rising electricity tariffs, with Eskom's rates increasing by over 60% in the past five years. These growing energy costs threaten profitability and long-term sustainability, making energy efficiency and innovative management essential priorities. Valterra Platinum, formerly known as Anglo American Platinum, is working to improve operational efficiency, cut its carbon footprint, and ensure the long-term viability of its operations amid an increasingly complex energy environment.

One of the projects identified at the Amandelbult mining complex focuses on the compressed air system. Compressed air systems are crucial in mining operations, not only powering various tools and machinery but also providing vital support for life-sustaining refuge chambers. Consequently, compressors are among the most energy-intensive systems, representing a significant portion of a mine's energy use. Inefficient operations, such as leaks, high-pressure supply, and malfunctioning components such as valves and actuators, inevitably result in energy wastage.

Significant energy savings were achieved through the implementation and monitoring of control valves on the compressed air system. These valves play a crucial role in regulating the pressure of the compressed air supplied to the various operations. By regulating the pressure, the system requires less airflow, which directly lowers the energy demand from the compressor system.

After gaining control over the valves, the pressure supply to various operations was dynamically adjusted to meet demand. This change reduced the flow of compressed air while still meeting operational needs. The pressure supply was further optimised throughout the day by leveraging the Eskom time-of-use tariff structure. Due to the altered compressed air demand profile caused by the control valves, the compressor schedule was also modified to maximise savings potential. This approach resulted in a cost saving of R56 million for 2024.

The control valves are monitored daily and require regular maintenance to sustain the savings. Daily reports have been created to monitor the status of each valve, enabling quick response if a valve fails.

Further optimisation is still possible; however, this initiative has not only improved the efficiency of the compressed air system but also contributed to a reduction in operational costs. The energy savings achieved through this initiative highlight the significance of operational efficiency and continuous energy management.

Waldo Biermann

Project Engineer
ETA Operations

I consider myself to be a dedicated and innovative engineer with nearly a decade of experience at ETA Operations, a leading engineering and technology consultancy based in Pretoria. During my tenure, I have played a key role in projects aimed at improving energy efficiency, systems optimisation, and sustainable engineering solutions within the mining sector.

While working full-time, I pursued and successfully completed my master's degree in engineering, further strengthening my technical and analytical

capabilities. This achievement complemented my practical experience in implementing advanced simulation tools, data-driven process optimisation strategies, and real-time control systems.

I have a practical, solutions-oriented approach, and have contributed to several high-impact initiatives that aligned with energy-saving goals. I am committed to innovation, continuous learning, and operational excellence. I believe I have made a lasting impact on both the projects I was a part of and the teams I have supported.

A framework for technology selection in large scale systems: Case study of mining technology selection applying system dynamics modelling

C. Mukonoweshuro
The University of the Witwatersrand, South Africa

Production is the act of producing new goods and services. The resources used in the production process and enabling production are called inputs or factors of production. There are many factors that contribute to the economic performance of an entity, such as capital, labour, energy, optimal allocation of technology sources, innovations, among others. Technology, which in essence falls under capital input, is one of the major production inputs. This paper analysed how two of the major production inputs, capital and labour, are influenced by the type of technology system being used to produce an output. The study applied systems dynamic modelling techniques to illustrate the impact of various factors on the output of platinum underground mining systems. The Cobb-Douglas function, which is the most used production function was modelled into systems dynamics software. Two technological systems were modelled: conventional mining systems which employ more labour vs mechanised systems which use machines to aid in the mining processes. The result of the modelling system illustrated how systems dynamic modelling can be an effective tool to analyse various factors which influence productivity instead of the traditional statistical regression analysis methodology. The result of this study will be used for further analysis of the qualitative impact of various technologies on the output of different mining systems. The goal is to then develop a framework which can be used by large systems for selecting technology.

Keywords: Systems dynamics modelling, Production function, Total productivity factors, Underground platinum mining.

Christopher Mukonoweshuro

PhD Candidate
University of the Witwatersrand, South Africa

I am a current PhD candidate at the University of Witwatersrand, holds an MSc engineering also from University of Witwatersrand and a BSc in mechanical engineering from the University of Zimbabwe. I am a Registered Professional Engineer with the Engineers Registration Board of Botswana (ERB) and I am a Member of South African Institute of Mechanical Engineers (SAIMechE) and the Southern African Institute of Mining and Metallurgy (SAIMM).

In terms of work experience, I have over 25 years working experience as an Engineer, Engineering Manager and Business manager mostly in the Mining industry and Energy Sector (oil and gas) across 9 different countries in Africa. I have worked for global mining equipment brands such as Sandvik and Caterpillar, and worked for and at some major mining houses such as Ashanti Gold, Zimplats (under Sandvik), BCL Nickel Mine in Botswana, Kenmare mine in Mozambique and Segala Mining in Mali West Africa.

My current PhD supervisor is Dr. Andries Botha who specialises in Systems

Elevating safety and efficiency in mining with vision AI: From object detection to LLM-driven decision intelligence

Y. Zhang[1], M.A.H. Zahid[1], T. Moodley[2]
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Mining operations are under growing pressure to improve safety and efficiency while dealing with ageing infrastructure, complex processes, and workforce constraints. Although many sites are equipped with surveillance cameras and control systems, critical events often go unmonitored or under-analysed due to the lack of intelligent interpretation tools. Cameras typically act as passive recorders, requiring manual review by control room operators; a process that is labour-intensive, error-prone, and reactive. Vision AI is emerging as a transformative solution, combining computer vision and artificial intelligence to deliver real-time, actionable insights. This technology has evolved along two key phases: traditional object detection, and more recently, multimodal large language model integration. This paper presents solution architectures, deployment results, and key insights from real-world implementations across underground operations, open-pit truck-shovel operations, and smelter operations, demonstrating how Vision AI is reshaping mining operations to become safer, more efficient, and more intelligent.

Keywords: Vision AI, computer vision, large language models, mining safety, operational efficiency, object detection

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Evaluating water performance on platinum mine shafts using a benchmarking technique

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South Africa's intensifying water scarcity poses a significant risk to the platinum mining sector, where a reliable water supply is essential for productivity, economic performance, and long-term operational sustainability. Effective water management is therefore critical, requiring the identification of inefficiencies and a focus on continuous improvement. While benchmarking is widely used to improve operational performance, its application to water systems in platinum mining remains limited due to a lack of industry-specific guidance. This paper addresses that gap by applying a structured benchmarking approach to assess water usage across platinum mining shafts through a case study methodology.

The evaluation followed three steps: assessing the performance of individual shafts, comparing performance across shafts, and identifying improvement opportunities based on internal comparisons and external industry benchmarks. The analysis of potable- and service water usage relative to production revealed a substantial variation—up to 51% in potable water and 34% in service water usage.

These disparities highlight clear opportunities for optimisation. Potential reductions in potable water use range from 1 – 51%, and in service water 9 – 34%. Key areas for improvement include leak detection and repair, reducing misuse of chilled and cooling water, enhancing dust suppression practices, improving water supply control during non-peak operational periods, and closing supply to inactive areas.

This paper demonstrates the value of structured benchmarking in identifying water performance gaps. By offering a practical framework for monitoring and improving water efficiency, it supports enhanced water stewardship and the long-term sustainability of platinum mining operations in a water-stressed South Africa.

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He serves as a Senior Project Engineer at ETA Operations, where he drives continuous improvement through operational efficiency projects. His work integrates advanced simulation, project management, and business improvement to support life-of-mine extension initiatives.

Instope water handling strategies to achieve a dry mine

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Water in underground mines is used for dust suppression, lubrication, cooling, and for cleaning the mining stopes. In the past, water usage was in the order of 1 to 2 tonnes of water per tonne of ore mined. With the reduction of mineral reserves, mining entities are opting to go deeper. As such, water consumption has increased to as high as 10 tonnes per tonne of ore mined. The substantial increase in consumption has resulted in inadequate handling of instope water. This leads to localised haulage flooding which damages ore- moving equipment (belts or locomotives) and is a threat to the productivity and profit of a mine. The purpose of this paper was to understand the current strategies for controlling instope water and propose an improved strategy. The improved strategy was developed through a case study methodology, in which underground audits of the instope water handling system at a case-study mine were performed. Data on the water handling strategies were obtained and analysed. From the analysis of the system's challenges, an improved method for instope water handling was developed with the use of simulation modelling. This improved method was then implemented in the case study mine. Results show an average decrease of 34% in flooding reports and a decrease of 27% in lost blasts due to flooding. With the aid of this improved strategy approximately R2.8 million of production revenue loss was avoided. With adequate maintenance, this figure can be improved upon and the goal of a dry mine achieved.

Keywords: Water Control, Lost Blast, Instope water, Mine Dewatering, Pumping, Simulation

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Lance Senda is currently part of a dynamic, young and energetic engineering team at ETA Operations a company aimed at optimizing industries. He is the holder of a bachelor's degree in mechanical engineering from the University of Pretoria and uses the gained skills in optimizing processes, conceptual design of solutions and execution of projects relating to water, energy and compressed air systems.

Currently Lance is in pursuit of his Masters in Engineering through NWU with a research topic focused on water as it is his keen interest and passion. Outside of work, he enjoys exploring the outdoors through the hiking trails of Gauteng, a lover of football with Premier League club Manchester United and a fan of film.

Time, water and energy to clean a stope panel using water jetting

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Water jets have been used successfully to clean blasted rock in stope panels in the narrow, slightly-dipping, tabular ore bodies of South African PGM and gold mines for since the early 1980s.

This paper describes a calculation model that estimates the jetting time and calculates the water and energy required for typical dip inclinations, reef types, panel dimensions and jet nozzle diameters. A straightforward methodology quantifies the cleaning TASK from the panel dimensions and estimates the cleaning RATE. This allows the cleaning TIME to be calculated and adjusted for a particular dip angle. The heart of the model is a power law correlation between the effective jet impact FORCE at 5 metres from the nozzle and the cleaning RATE at a standard DIP. The methodology includes an allowance for the drop-off of the impact force with distance from the nozzle, rock that is throw-blasted directly into the gully, and a THRESHOLD force below which jet cleaning is ineffective. The power law parameters are determined by curve fitting measured cleaning RATE data with the effective jet impact FORCE.

The Jet Cleaning Model allows panel lengths to be optimized for cleaning and the most suitable jet cleaning tool and power pack to be selected. The model also allows an estimated reduction in cleaning cycle time to be converted into a probable improvement in average production using a simple statistical approach.

In addition, key practical issues are discussed including safety, mud-rush risk, dirty water management, effects on stope environmental conditions, and the matching of power pack capacity for both water hydraulic drilling, and cleaning.

Keywords: Water jet stope panel cleaning, cleaning time calculation, water usage, energy usage

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Peter Fraser is a Professional Engineer and holds master's degrees in both mechanical engineering and business administration. He started his career with the Chamber of Mines Research Organisation (COMRO) and has recently retired from Hydro Power Equipment (HPE) where he was involved with innovation and growing market awareness of the water hydraulic mining solutions for nearly 28 years. Peter has contributed many papers to the Southern African Institute of Mining and Metallurgy mainly focusing on the performance, water usage and energy consumption of water hydraulic mining equipment.

Automating energy baseline development for energy-intensive mining systems in South Africa

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The mining industry in South Africa is under pressure to reduce energy use due to national electricity constraints. This pressure makes timely energy efficiency intervention critical. Mining systems, such as compressed air, ventilation, and refrigeration, use energy to support operations. Energy data is one of the primary parameters utilised by mines to assess the performance of these systems and develop baseline profiles. These profiles are essential for measuring improvements and identifying inefficiencies. Energy consumption datasets are inherently large due to frequent sampling, multiple points of measurement, and extended retention periods. These large datasets, along with the effort required to develop baseline profiles, present a significant challenge. Traditional methods are often unable to process the datasets within a reasonable time frame. As a result, there are delays in performance assessment. Automating the process is therefore advantageous for obtaining baseline profiles with reduced time and effort. To solve this problem, an automated script, based on a combination of existing methods from literature and industry good practices, was developed and compared against a traditional method, through a comparative case study of an energy-intensive mining system. This script generated accurate daily energy consumption baseline profiles while reducing processing time by 99%, as well as minimising human intervention. The success of this automated baseline development in an energy-intensive mining system has prompted us to consider rolling it out to other energy-intensive mining systems and relevant non-mining operations.

Keywords: Automation, energy consumption baseline profiles, energy-intensive mining systems, large **datasets**, time and effort reduction

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Ndumbi is an optimist and dedicated engineer in the energy management field.

He completed his Bachelor of Technology in Industrial Engineering at the Tshwane University of Technology in 2019.

From June 2021 to May 2023, he worked as a Control Room Engineer, where he was actively involved in live system operations. His responsibilities included optimising compressed air systems, monitoring energy initiative projects and assisting with power control execution. Operating across rotating shifts, including morning, afternoon and night helped him to develop solid situational awareness and quick decision-making skills.

Since June 2023, he has held the role of Engineer in Utility Management, where he specialises in building and maintaining daily utilities reports within a digital infrastructure. To date, he has developed over 15 detailed daily utilities reports used to track energy consumption trends, evaluate energy performance and identify improvement opportunities. These reports support data-driven decision-making across engineering departments and contribute to measurable energy and cost savings.

In this role, he also assists as the first point of contact for system and data support requests within the energy and utility management team. He assists with troubleshooting, dashboard support and ensuring continuous access to accurate and reliable data across platforms.

A significant focus of his present work involves developing energy baseline profiles for performance reporting. He applies statistical and engineering methods to ensure these baseline profiles are accurate, reliable and aligned with efficiency initiative projects.

While working, he is also pursuing his master's degree in industrial engineering at the Tshwane University of Technology.