DSTI-NRF CIMERA Annual Research

COLLOQUIUM'25

cimera

DSTI-NRF CIMERA
Centre of Excellence for
Integrated Mineral and Energy
Resource Analysis

ABSTRACT BOOKLET

science, technology & innovation
Department:
Science, Technology and Innovation
REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation | RISA Research and Innovation Support and Advancement

UNIVERSITY OF JOHANNESBURG 2005 2025 20 YEARS

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Photo Credit: René Booysen, Helmholtz-Zentrum Dresden-Rossendorf e.V.

DSTI-NRF CIMERA ANNUAL RESEARCH COLLOQUIUM

24 & 25 November 2025

at the

University of Limpopo

Earth Science Building

DSTI-NRF CIMERA – Centre of Excellence for Integrated Mineral and Energy Resource Analysis
Department of Geology
University of Johannesburg | Auckland Park Kingsway Campus [APK]
PO Box 524 | 2006 Auckland Park | South Africa
+27 11 559 4728 [tel]
cimera@uj.ac.za | www.cimera.co.za

Dear All,

We are delighted to welcome all delegates to the 2025 DSTI-NRF CIMERA Annual Research Colloquium (ARC), hosted by the University of Limpopo (UL) Department of Geology and Mining, in the new Earth Science Building. We are celebrating the growth of geosciences at UL, the successful partnership CIMERA has with UL, as well as the postgraduate students funded through DSTI-NRF CIMERA. We are extremely grateful to UL Geology and Mining and the University Management for providing the opportunity to visit UL and Polokwane.

The ARC, held for the first time outside of Johannesburg, provides a platform for the DSTI-NRF CIMERA supported postgraduate students, researchers, and academics from across South Africa to come together and share their research findings stemming from the economic geology and geoscience for society projects supported by DSTI-NRF CIMERA. We have put together a full program, with opportunities to share scientific findings as well as time for networking, reconnecting with peers and making new connections. And we hope to see as many people as possible at our evening event on the 24th November, a time to relax and socialise under the African sky.

The 2025 ARC program lists 22 postgraduate presentations, 14 poster presentations, and two keynote presentations. As well as a 'softskills' workshop facilitated by Women in Mining South Africa (WiMSA).

We are extremely pleased to welcome the two keynote speakers:

- Mr Nevan Pillay: Chair of the DSTI-NRF CIMERA Steering Committee / Vedanta
- Ms Busisiwe Maphalala: DSTI-NRF CIMERA Centre Manager

At the close of the scientific program, we will announce the prizes for the best poster and presentation. And present the results from the 'Translate your research' competition. Following this, the students will participate in a soft skills workshop facilitated by WiMSA: "Building Confident, Financially Astute, and Innovative Leaders". The workshop will expose postgraduate students to many aspects required for the workplace and life after graduation.

DSTI-NRF CIMERA brings together research excellence, capacity, and resources to enable collaboration across geoscience disciplines and institutions on long-term projects of economic and/or societal benefit in geosciences, in research that is locally relevant and internationally competitive. The CoE currently provides direct and indirect funding support to over 70 postgraduate students hosted at 12 geology departments across South Africa. The outputs of the research benefit the region and the continent, as does the pool of skilled graduate students. Geology and the mining industry are back-bones of the South African economy, and geoscientists play a vital role in the development of the low carbon economy. Please visit our website (www.cimera.co.za) and follow us on LinkedIn, Facebook and other social media platforms for more information on our goals, research focus areas, and activities.

Congratulations to all students on the achievements in your studies to date, and we look forward to interacting with you over the next two days.

Regards,

Professor Nikki Wagner
Director: DSTI-NRF CIMERA
nwagner@uj.ac.za

KEYNOTE SPEAKER 1: Mr Nevan Pillay

BIOGRAPHY ▪ **Nevan Pillay** was appointed as Head of Exploration at Vedanta Zinc International on 1 September 2022. He is a geologist with over 25 years' experience in the mining industry.

Since completing his initial academic studies in 2000, he has worked in various positions in the mining and exploration field within Junior, Mid-tier and Major multi-national companies. He has held the position of Group Manager Geology (Norilsk); General Manager for African Exploration (Rio Tinto), Johannesburg Office Head (Rio Tinto) and HOD Mining Studies (MSA), among others.

He is a competent person with regards to sediment hosted copper, alaskite hosted uranium, magmatic nickel deposits and VMS/Sedex Pb-Zn deposits. He has led exploration projects and studies in Angola, Botswana, Namibia, South Africa, Mozambique, Canada, Burundi and Zambia. He is currently on the Exco of VZI in charge of the exploration/ growth strategy and new business development.

Image: Aerial view of massive sand dunes in the arid region of the Northern Cape, South Africa. By EcoView. Stock.Adobe.com

KEYNOTE SPEAKER 2: Ms Busisiwe Maphalala

BIOGRAPHY ■ **Busisiwe Maphalala** was appointed as the CoE Manager at DSTI-NRF CIMERA in May 2025. She is a professional with over 8 years in the mining industry.

After completing her degree in Geology, she began her career as a Geologist at AngloGold Ashanti. She later joined the Council for Scientific and Industrial Research (CSIR), where she developed extensive experience in research and project management. Her research work covered a wide range of topics within the mining industry, including critical minerals, skills for modernized mines, circular economy, and energy use in mining. Her ongoing interests include sustainability in the mining industry, with a particular focus on exploration, mineral extraction, and skills needed to ensure the industry's long-term sustainability.

Image: South African river canyon. By lkpro. Stock.Adobe.com

PROGRAMME

DAY 1: **MONDAY 24 NOVEMBER 2025**				
		07:15	BUS WILL DEPART FROM HOTEL TO VENUE	
		08:00 – 09:00	REGISTRATION AND TEA	
		09:00 – 09:10	**Prof Nicola Wagner** (UJ) DSTI-NRF CIMERA Director	WELCOME
		09:10 – 09:30	Invited Representatives from UL: VC / DVC / Dean Faculty of Science and Agriculture	WELCOME NOTES
	SLOT	TIME	PRESENTER	TOPIC
SESSION 1: CHAIRS ▪ Prof Nicola Wagner (UJ, CIMERA Director) and Prof Susan Webb (Wits, CIMERA Co Director)		09:30 – 10:00	KEYNOTE SPEAKER **Mr Nevan Pillay** Vedanta Resources / Chair of DSTI-NRF CIMERA Steering Committee	**Putting Theory into Practice – An Explorer's Journey.**
	1	10:00 – 10:20	**Charl D Cilliers** (UWC)	Virtual Field Trips: Preparing students for geological fieldwork in South Africa
	2	10:20 – 10:40	**Fatima Chitlango** (UJ)	Paleo-depositional environmental reconstruction for the Permian Vereeniging-Sasolburg Coalfield, South Africa.
	3	10:40 – 11:00	**Busisiwe Khoza** (Wits)	Resolving the B3 Group Paradox: New Isotopic Evidence for the Parental Magmas of the Main and Upper Zones of the Bushveld Complex and its Implications for Bushveld Mineralization.
		11:00 – 11:30	TEA BREAK	
SESSION 2: CHAIR ▪ Elelwani Denge (UL)	4	11:30 – 11:50	**Julia Mapula Maponya** (UV)	Genesis and Mode of Occurrence of Magnetite-Rich Iron Ore within Gabbronorite of the Bushveld Igneous Complex: Evidence from Petrography, XRD, and Geochemistry.

PROGRAMME (cont.)

SESSION 2: CHAIR ▪ Elelwani Denge (UL)	5	11:50 – 12:10	**Faith Nyati** (Wits)	High-precision Geochronology of the Rooiberg Group to Constrain the Shallow Crustal Effects of the Bushveld LIP.
	6	12:10 – 12:30	**Treyen Pillay** (Wits)	Interrogation of borehole geophysical data from the International Continental Scientific Drilling Program (ICDP) of the Bushveld Drilling Project (BVDP) for lithology determination.
	7	12:30 – 2:50	**Thabiso Sibanyoni** (UJ)	Using structural geology and geochronology to constrain the emplacement age of mafic-ultramafic Ombuku South and Otjijanjasemo intrusions at the periphery of the Kunene Complex, northern Namibia.
		12:50 – 13:40	GROUP PHOTOGRAPHS AND BUFFET LUNCH; PUT UP POSTERS AFTER LUNCH	
SESSION 3: CHAIR ▪ Dr Marvin Moroeng (UJ)	8	13:40 – 14:00	**Kaydi Govender** (Wits)	Constraining the magma sources and tectonic setting of the Kunene AMCG Complex.
	9	14:00 – 14:20	**Chanelle du Plessis** (UP)	Insights into mantle processes of the Cullinan kimberlite (previously Premier kimberlite) pipe, Kaapvaal craton, South Africa.
	10	14:20 – 14:40	**Khulekani B Khumalo** (Wits)	Tracing Magmatic Ores: Setting-up Fe-Cu-Zn Stable Isotope Methods to Trace Mineralisation in Layered Intrusions.
	11	14:40 – 15:00	**Thabo S Kgarabjang** (UL)	Gold Distribution in Arsenic, Antimony-Bearing Sulphides at the Stibium Mopani Gold-Antimony Deposit, Murchison Greenstone Belt, South Africa: Evidence for Refractory Gold Mineralization.
	12	15:00 – 15:15	POSTER PRESENTATIONS (timed 1-minute elevator pitches; 14 presenters)	
		15:15 – 15:50	COMFORT BREAK AND POSTER VIEWING	

PROGRAMME (cont.)

SESSION 4: CHAIR ▪ Prof Napoleon Hammond (UL)	13	15:50 – 16:10	**Daniel Ferreira** (SU)	The Tantalite Valley Complex: Insights into its genesis and evolution.
	14	16:10 – 16:30	**Munyai Phumudzo Gift** (UV)	Phytoremediation of metals from Klein Letaba gold mine tailings, Limpopo Province, South Africa.
	15	16:30 – 16:50	**Nthatisi Sandra Makhoba** (Wits)	Paragenesis of different styles of magmatic sulphide mineralisation in the mafic-ultramafic phase of the Kunene Complex, Angola.
	16	16:50 – 17:10	**Tahnee Otto** (SU)	Experimental investigation of Bushveld chromitite formation II: The story from sintered olivine capsules.
		17:20	DEPARTURE FOR NETWORKING EVENT	
		18:00 – 21:00	NETWORKING SESSION AND BRAAI	

Image: The International Continental Scientific Drilling Programme (ICDP) Bushveld Drilling Project 2025.

PROGRAMME (cont.)

DAY 2: **TUESDAY 25 NOVEMBER 2025**				
		07:30	BUS WILL DEPART FROM HOTEL TO VENUE	
		08:00 – 08:45	REGISTRATION AND TEA	
		08:45 – 09:00	**Prof Sue Webb** (Wits) DSTI-NRF CIMERA Co-Director & Prof NQ Hammond (UL)	WELCOME
	SLOT	TIME	PRESENTER	TOPIC
SESSION 5: CHAIR ▪ Dr Maropene Rapholo (UL)	17	09:00 – 09:20	**Fezeka Dliwako** (Wits)	Tectonic processes affecting the central Kaapvaal Craton: evidence from esoarchaean TTGs from the Johannesburg Dome.
	18	09:20 – 09:40	**Nthabeleng Ramotholo** (UKZN)	The Metallogeny of the mafic-ultramafic Sithilo Complex, Tugela Terrane, Natal Metamorphic Province.
	19	09:40 – 10:00	**Zakhele Radebe** (UJ)	Organic petrography, mineralogy and sulphur distribution within the n0.2 seam in the Belfast coal mine, Witbank coalfield, South Africa.
	20	10:00 – 10:20	**Catherine Grobbelaar** (UCT)	Hyperspectral mineral identification for geological mapping and REE exploration.
	21	10:20 – 10:40	**Khethukuthula Ndebele** (UCT)	Premier kimberlite cluster megacrysts: constrains on kimberlite melt evolution in Bushveld-modified lithosphere.
		10:40 – 11:10	TEA BREAK	
	22	11:10 – 11:30	**Goitseone Benedict** (UP)	Fe-Ti oxides as a proxy for metallogenic processes in mafic/ ultramafic intrusions peripheral to the Kunene AMCG Complex in Angola.

PROGRAMME (cont.)

SESSION 6: CHAIR ▪ Dr Karen Smit (Wits)	22	11:30 – 11:50	**Chanelle du Plessis** (UP)	Insights into mantle processes of the Cullinan kimberlite (previously Premier kimberlite) pipe, Kaapvaal craton, South Africa.
	23	11:50 – 12:20	KEYNOTE SPEAKER **Busiswe Maphalala** (UJ) CoE Manager	**The Changing Face of Geosciences: Towards a Regenerative and Responsible Future.**
		12:20 – 13:00	LUNCH and PROFESSIONAL PHOTOGRAPHS	
		13:00 – 13:15	Translate your research presentations and winners; presented by Directors	
		13:10 – 13:30	Best presentation & poster, vote of thanks, & Colloquium close, + video	
		13:30 – 16:00	Soft Skills workshop (students); discussion forum (academics)	
		16:10 – 20:30	BUS DEPARTURE FROM VENUE TO JOHANNESBURG	

Image: The International Continental Scientific Drilling Programme (ICDP) Bushveld Drilling Project 2025.

POSTER PROGRAMME

15:00 – 15:50 **MONDAY 24 NOVEMBER 2025**	
PRESENTER	TOPIC
Jazmynn Eksteen (UKZN)	Geological controls on unconsolidated sediment and non-diamond placer distribution in the 20 to 14 A-C diamond concessions, Saldanha Bay to Strandfontein shelf
Liseloane Lucia Malelu (WITS)	Integrated Geometallurgical and Mineralogical Assessment of Vanadium in Magnetite of the Upper Zone in the Bushveld Complex
Puleng Nthebe (WITS)	Thermochemical impact of tectonic processes on the lithospheric mantle beneath the SE margin of the Kaapvaal Craton: using mantle xenoliths from Lesotho
Bokani Moyo (UCT)	Enhancing diamond breakage classification using the morphology of natural stones
Matebello Mokoena (WITS)	Sulphide paragenesis mechanisms in the Okiep Copper Deposits, South Africa
Ishta Maharaj (UKZN)	Detailed bedrock morphology and structural geology controls on diamond traps offshore Hottentot's Bay, Southern Namibia.
Dr Fritz A. Agbor (UWC)	Thermal Maturity History and Hydrocarbon Generation Modelling within The Southern Pletmos Sub-Basin, Offshore South Africa.
Wayne Nel (UFS)	The iron formations of the eastern Mesoproterozoic Aggeneys Terrane, and their significance to Zn-Pb deposits.
Thoriso Lekoetje (WITS)	Zircon–Baddeleyite Co-crystallisation and Accessory Phase Behaviour in Mafic Magmas: Insights from the Kunene Complex
Masonwabe Jubase (WITS)	Mineralogical and Petrogenetic Characterization of Witkop Pegmatites, Northern Cape, South Africa
Amahle Ngcobo (UKZN)	Investigating the Bethal Limb of the Bushveld Complex
Mphanama Thangeni (UV)	Petrography and Mineralogy of Copper-Bearing Rocks in the Mutale Copperfield, Soutpansberg Group
Mangapa Moloto (UL)	Characteristics of ore mineralogy associated with gold mineralization in the Windmill orebody, Kalahari Goldridge deposit, Kraaipan greenstone belt, South Africa
Thabiso Mokobodi (UL)	Geological mapping and investigation of natural hydrogen gas potential in the Nkangala district, Mpumalanga province, South Africa.

TITLE	**Virtual Field Trips: Preparing Students for Geological Fieldwork in South Africa**
PRESENTING AUTHOR	**Dr Charl D Cilliers**
UNIVERSITY	University of the Western Cape (UWC)
EMAIL ADDRESS	charlcilliers75@gmail.com; 2475326@uwc.ac.za
SUPERVISOR/S NAME/S	Prof Jan van Bever Donker
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	GEOLOGY FOR SOCIETY
REGISTERED DEGREE	Postdoctoral Research Fellow (PDRF)
ORAL OR POSTER	Oral

South Africa's geological diversity encompasses sites of exceptional scenic, historical, educational, and economic value, including the Barberton greenstones and stromatolites, Ecca Group turbidites at Laingsburg, deformed Cape Fold Belt sediments, and the Sea Point Contact granites. In response to the need for Geoheritage preservation and public engagement, institutions such as the Geological Society of South Africa (GSSA) have initiated efforts to document and promote geological literacy through its Geoscience and Society Division.

Aligned with these goals, we have developed virtual field trips (VFTs) showcasing accessible outcrops of the Cape Granite, Cape Supergroup, and Karoo Supergroup. These VFTs are designed to support university-level education, particularly in preparing students for fieldwork and enhancing conceptual understanding. Using a DJI Mavic 3 Pro Cine drone, iPhone 15 Pro Max with LiDAR, lapel microphones, Pano2VR software, and Google Earth, we have produced interactive VFTs featuring aerial perspectives, geo-located 360° imagery, 3D scans, annotated photographs, embedded videos with subtitles, scientific references, and quizzes.

Building on prior findings (2023–2024) that VFTs improve student comprehension of sedimentary, structural, and igneous processes, we expanded our study in 2025 to include 175 first-year and 43 third-year students. First-year completed a baseline multiple-choice test was completed, followed by VFT exposure with explanations and followed by a repeat assessment. Third years received lectures and materials prior to testing, then engaged with a VFT for one week before retesting via Google Forms. Results showed marked improvement: average scores increased by ~36% for first-years and ~42% for third-years.

Despite these promising outcomes, our delivery methods require refinement. Preliminary trials suggest that 3DVista software may offer a more effective e-learning interface, with embedded media and integrated quizzes that enable logical progression through content. Based on student feedback, future iterations will incorporate thin-section and macro-photographic imagery, including super high-resolution visuals generated via our in-house GIGAmacro® system.

These enhanced VFTs will be presented at the research colloquium, where we invite feedback on our methodology, educational impact, and broader applications in geoheritage and geoscience pedagogy.

TITLE	**Paleo-Depositional Environmental Reconstruction for the Permian Vereeniging-Sasolburg Coalfield, South Africa**
PRESENTING AUTHOR	**Fatima Chitlango**
UNIVERSITY	University of Johannesburg (UJ)
EMAIL ADDRESS	zonkechitlango@gmail.com
SUPERVISOR/S NAME/S	Prof Nicola Wagner
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	ENERGY RESOURCES
REGISTERED DEGREE	PhD
ORAL OR POSTER	Oral

The DMPR (2025) published a list of critical minerals for South Africa and identified coal as a "high criticality mineral". To this end, research into the South African coal deposits is required to ensure ongoing supply. Forty (40) coal samples from four boreholes drilled as part of an exploration project in the Vereeniging-Sasolburg Coalfield, Coalbrook Sub-basin, South Africa, were studied to understand the paleo-depositional environment of the mire using organic petrography (macerals, microlithotypes, and vitrinite reflectance), geochemistry (XRF, rare earth and trace elements data), and mineralogy. The study aims to expand the understanding of this part of the Main Karoo Basin (MKB). The samples are classified as low-rank A sub-bituminous to medium-rank D bituminous with variable maceral composition, dominated by inertinite group macerals ranging from 42.0 to 90.6 vol % (semifusinite, fusinite, and inertodetrinite) and moderate vitrinite (at 5.8 to 48.0 vol %). The dominance of inertinite suggests oxidation and paleofires in and around the mire with V/I ratios varying from 0.06 to 1.14 (highest in sample B from SLD01a) and suggests a dry and oxidizing paleoenvironment except for sample B from SLD02a. The occurrence of both inertinite and vitrinite also reflects variations in the paleomire conditions, from oxic to anoxic. Sr/Cu and U/Th ratios ranging from 1.24 to 49.28 and 0.1.0 to 0.32 as well as positive and slight negative Ce anomalies indicate climatic variations between humid and arid conditions, with a predominance of dry conditions. Geochemical ratios of Th/U and Sr/Ba ratios suggest a transitional semi-brackish to freshwater depositional setting influenced by sea level fluctuations, with a dominance of freshwater settings.

The dominant minerals in the studied coals are kaolinite (mainly detrital) and quartz (detrital), showing a syngenetic mode of occurrence. Authigenic kaolinite precipitated in cell lumens and maceral pores under acidic pH levels. Al2O3/TiO2 ratios indicate that the detrital minerals in the coals were mostly derived from intermediate and felsic sources. EuN anomaly values for all the samples studied are less than 1, ranging from 0.45 to 0.97 (0.69 avg.). Negative Eu anomalies may arise from various geological processes including intense weathering, oxidizing conditions, and high-temperature fluids, whereby Eu3+ is reduced to mobile Eu2+. Thus, the observed negative Eu anomalies indicate oxidizing conditions as opposed to hydrothermal input. In addition, the negative Eu anomalies further support a felsic to felsic-intermediate source region. The microlithotypes facies plot suggests that the coals were deposited in lacustrine and lower deltaic depositional environments.

TITLE	**Resolving the B3 Group Paradox: New Isotopic Evidence for the Parental Magmas of the Main and Upper Zones of the Bushveld Complex and its Implications for Bushveld Mineralization**
PRESENTING AUTHOR	**Busisiwe Khoza**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	687999@students.wits.ac.za
SUPERVISOR/S NAME/S	Dr B Hayes and Prof LD Ashwal
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	LARGE IGNEOUS COMPLEXES
REGISTERED DEGREE	PhD
ORAL OR POSTER	Oral

The Rustenburg Layered Suite (RLS) hosts significant ore deposits of platinum-group elements (PGE), vanadium (V), and chromium (Cr). Interpreting the formation mechanisms of these deposits requires accurate estimations of the parental magma compositions that filled the RLS chamber, and the types of material (melt versus slurries) emplaced within the RLS. For over a century, estimates for the major oxides and trace elements in these magmas have been derived from the marginal rocks of the RLS. In 2001, Curl confirmed isotopic similarities between the Marginal Zone rocks and the overlying layered series, which was postulated to validate the Marginal Zone rocks as estimates for the RLS parental magma compositions. Curl (2001) established strong isotopic correlations between the B1 group (estimate for the B1 magma) and the Lower and Lower Critical Zones, as well as between the B2 group (estimate for the B2 magma) and the Upper Critical Zone. However, the B3 group presented an apparent paradox: its strontium isotopic compositions ($87Sr/86Sr_i$ = 0.7059–0.7072; Harmer and Sharpe, 1985; Curl, 2001) were significantly less radiogenic than those of the Main Zone ($87Sr/86S_i$ = 0.7085; Roelofse and Ashwal, 2012), despite direct field contacts between B3 and Main Zone cumulates. However, the $87Sr/86Sr_i$ of the B3 groups are postulated to be related to the petrogenesis of Upper Zone ($87Sr/86Sr_i$ =0.7072–0.7075). This study presents a higher-density dataset of Sr–Nd isotopic compositions for the B3 group of the Marginal Zone, which revealed that the B3 group comprises two isotopically distinct subgroups: one (B3m) overlapping the Main Zone ($87Sr/86Sr_i$ = 0.70839–0.70862) and another (B3u) overlapping the upper zone ($87Sr/86Sr_i$ = 0.7054–0.7075; Maier et al., 2013). These results resolve the long-standing B3 paradox by demonstrating that all groups within the Marginal Zone can be isotopically linked to the overlying layered sequence. This provides a crucial tool for understanding the petrogenesis of the parental melts, the Marginal Zone, and the layered series, thereby enhancing our comprehension of how the RLS mineral resources concentrated to form these significant deposits. This study underscores the isotopic complexity of marginal zone magmas and highlights their fundamental role in the petrogenesis and mineralization of the RLS.

TITLE	**Genesis and Mode of Occurrence of Magnetite-Rich Iron Ore within Gabbronorite of the Bushveld Igneous Complex: Evidence from Petrography, XRD, and Geochemistry**
PRESENTING AUTHOR	**Julia Mapula Maponya**
UNIVERSITY	University of Venda
EMAIL ADDRESS	Mapulajulia4@gmail.com
SUPERVISOR/S NAME/S	Dr HR Mundalamo and Prof JS Ogola
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANGANESE AND IRON ORE DEPOSITS
REGISTERED DEGREE	Master of Earth Sciences in Mining and Environmental Geology
ORAL OR POSTER	Oral

The study area is situated within the Sekhukhune District Municipality, Limpopo Province, and forms part of the Rustenburg Layered Suite of the Bushveld Igneous Complex. Geological mapping confirmed that the host rock is gabbronorite, with the iron ore mineralization spatially controlled by structural conduits. The ore occurs as veins, veinlets, stockworks, stringers, and finger-like bodies that cut through the gabbronorite.

Petrographic study revealed the presence of feldspar, mainly plagioclase in gabbronorite, and minor concentration of oxides, mainly magnetite. Some rock specimens revealed a high concentration of magnetite especially those located near the host rock-orebody contact. Reflected light microscopy was done to establish the mineralogy of iron ore and to ascertain the relationship of the ore minerals. The main ore minerals were magnetite and hematite with minor ilmenite. The XRD results revealed high content of magnetite (92 %), followed by hematite (61%), then ilmenite (12%). The XRF results revealed gabbronorite with minimum and maximum FeO_3 wt% of 1.31% and 44.22% respectively, while minimum and maximum values of FeO_3 wt% in magnetite ore samples were found to be 43.38% and 54.55% respectively with an average value of 52.36%. The magnetite registered high concentration values of Zn (221 ppm), Ni (225 ppm), Co (163 ppm), Cr (503 ppm) and V (8981 ppm).

The mineralization is interpreted to have formed through magmatic differentiation and fractional crystallization processes within the layered intrusions of the Bushveld Igneous Complex. Structural features acted as pathways for ferruginous melts, which crystallized into iron-oxide-rich veins and stockworks. The association with vanadium, chromium, nickel, zinc, and cobalt reflects the magmatic–hydrothermal affinity of the ore system, typical of Bushveld magnetite deposits.

The genetic model is best classified as a magmatic–hydrothermal iron oxide deposit associated with layered mafic intrusions (comparable to vanadiferous titanomagnetite deposits of the Bushveld).

The iron ore in the study area is hosted within gabbronorite, forming through fractional crystallization and structural control. The magnetite ore is of good grade (>50% Fe_2O_3) and enriched in economically significant elements (V, Cr, Ni, Zn, Co). Further geophysical surveys and borehole drilling are recommended for detailed resource evaluation and potential economic exploitation.

Keywords: Iron ore, Bushveld Igneous complex, Rustenburg Layered Suite, Mode of occurrence

TITLE	**High-Precision Geochronology of the Rooiberg Group to Constrain the Shallow Crustal Effects of the Bushveld LIP**
PRESENTING AUTHOR	**Faith Nyathi**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	2364547@students.wits.ac.za
SUPERVISOR/S NAME/S	Dr Scott Maclennan and Prof Nils Lenhardt
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	METALLOGENY AND PALEOGEOGRAPHIC IMPLICATIONS OF LAYERED IGNEOUS COMPLEXES (LICs) AND LARGE IGNEOUS PROVINCES (LIPs)
REGISTERED DEGREE	Master of Science By Dissertation
ORAL OR POSTER	Oral

The Bushveld Complex represents the most significant layered intrusion in the world. It serves as one of the most important global sources of Platinum Group Metals (PGMs), vanadium, and chromium (Eales and Cawthorn, 1996). The Bushveld Complex is divided into the Rustenburg Layered Suite, the Lebowa Granite Suite, and the Rashoop Granophyre Suite (SACS, 1980). This complex intruded into the Rooiberg Group, which is recognised as one of the biggest and most unique Silicic Large Igneous Province (Schweitzer et al., 1995).

The available geochronology indicates that the Rooiberg Group predates Bushveld Complex magmatism by several million years (e.g., Walraven, 1997; Harmer and Armstrong, 2000), whereas field relationships and geochemistry suggest a very short temporal difference (e.g., Van Tongeren et al., 2010; Mathez et al., 2013). Consequently, recent studies propose that the Rooiberg Group serves as the extrusive counterpart of the Bushveld Complex (Joyalemi, 2015; Joyalemi et al., 2020).

This study focused on using U-Pb Chemical Abrasion Isotope Dilution Thermal Ionisation Mass spectrometry (CA ID TIMS) high-precision zircon geochronology to constrain the chronology of the stratigraphy of the Rooiberg Group. Statistical techniques, including the Bayesian age-depth model, were used to determine the eruption ages and eruption rates of the stratigraphy of the Rooiberg Group. The results reveal minimal age difference between the Rooiberg Group and the Bushveld Complex, which suggests that they share a contemporaneous relationship.

REFERENCES

Eales, H.V. and Cawthorn, R.G., 1996. The Bushveld complexes. In Developments In petrology (Vol. 15, pp. 181-229). Elsevier.

Harmer, R.E. and Farrow, D., 1995. An isotopic study on the volcanics of the Rooiberg Group: age implications and a potential exploration tool. Mineralium Deposita, 30, pp.188-195.

Jolayemi, O.O., 2015. Chemical Evolution of the Paleoproterozoic Rooiberg Group Kaapvaal Craton South Africa: New Insights into the Formation of a Silicic Large Igneous Province(SLIP). University of Pretoria (South Africa).

Jolayemi, O.O., Robb, L., Lenhardt, N. and Hughes, H.S., 2020. Different melt source regions for the volcanics of the Bushveld large igneous province: New observations from MELTS modelling of the Palaeoproterozoic Rooiberg Group (South Africa). Journal of African Earth Sciences, 172, p.103999.

Mathez, E.A., VanTongeren, J.A. and Schweitzer, J., 2013. On the relationships between the Bushveld Complex and its felsic roof rocks, part 1: petrogenesis of Rooiberg and related felsites. Contributions to Mineralogy and Petrology, 166, pp.435-449.

Schweitzer, J.K., Hatton, C.J. and De Waal, S.A., 1995. Economic potential of the Rooiberg Group: volcanic rocks in the floor and roof of the Bushveld Complex. Mineralium Deposita, 30,pp.168-177.

Van Tongeren, J.A., Mathez, E.A., Kelemen, P.B., 2010. A felsic end to Bushveld differentiation. Journal of Petrology. 51, Issue 9: 1891-1912.

Walraven, F., 1997. Geochronology of the Rooiberg Group, Transvaal Supergroup, South Africa (No. 316). University of the Witwatersrand

TITLE	**Interrogation of Borehole Geophysical Data from the International Continental Scientific Drilling Program (ICDP) of the Bushveld Drilling Project (BVDP) for Lithology Determination**
PRESENTING AUTHOR	**Treyen Pillay**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	treyen.pillay@gmail.com
SUPERVISOR/S NAME/S	Assoc Prof Musa Manzi, Dr Stephanie Enslin and Prof Susan J Webb
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	METALLOGENY AND PALEOGEOGRAPHIC IMPLICATIONS OF LAYERED IGNEOUS COMPLEXES (LICs) AND LARGE IGNEOUS PROVINCES (LIPs)
REGISTERED DEGREE	Master of Science By Dissertation
ORAL OR POSTER	Oral

The International Continental Scientific Drilling Program (ICDP) was established to provide access to high-quality records of Earth's history through targeted scientific drilling. Under this program the Bushveld Drilling Project (BVDP) was established to create a complete stratigraphic reference section to investigate the geology, geomicrobiology and deep groundwater systems of the Eastern Bushveld Complex. With the addition of six kilometres of donated core the Eastern Bushveld Complex has an essentially complete stratigraphic section. In addition to the collection of core, the BVDP collected borehole geophysical datasets. A nearby borehole, CH7, originally drilled by Anglo American as part of their detailed exploration programs in the Eastern Bushveld also offers additional geophysical borehole data.

Physical property data are fundamental to interpretation of all geophysical datasets including seismic, gravity, electromagnetic, and magnetic surveys and therefore demand rigorous interrogation to ensure reliability. Both the BVDP and CH7 geophysical borehole datasets provide measurements of density, seismic velocity, magnetic susceptibility, and electrical conductivity. This creates an opportunity to evaluate the quality of lithology logs using the geophysical logs.

Careful examination reveals that density values are effective in distinguishing chromitite layers, with massive chromitite displaying consistently higher densities than disseminated chromitite. Magnetic susceptibility is useful for identifying dolerite dykes and zones of olivine alteration, particularly within harzburgite, while seismic velocity is sensitive to alteration processes, with lower seismic velocities reflecting increased alteration.

Ensuring the quality of these measurements first requires quality control procedures such as cleaning the data. Outliers and spikes in the datasets, often linked to the calliper being out of range, were identified and removed. This step improves the accuracy and reliability of the dataset. Building on this cleaned dataset, a five-parameter methodology was developed to evaluate lithological ranges. This involved cross-plotting data points and applying the k-means clustering algorithm to classify lithological groupings more robustly.

The careful interrogation of physical property data by statistical clustering and geological reasoning leads to improvements and insight to the lithology data within the Eastern Bushveld Complex.

TITLE	**Using structural geology and geochronology to constrain the emplacement age of mafic-ultramafic Ombuku South and Otjijanjasemo intrusions at the periphery of the Kunene Complex, northern Namibia**
PRESENTING AUTHOR	**Thabiso Sibanyoni**
UNIVERSITY	University of Johannesburg
EMAIL ADDRESS	tsibanyoni@uj.ac.za
SUPERVISOR/S NAME/S	Prof Jérémie Lehmann, Dr Ben Hayes and Prof Lorenzo Milani
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	METALLOGENY AND PALEOGEOGRAPHIC IMPLICATIONS OF LAYERED IGNEOUS COMPLEXES (LICs) AND LARGE IGNEOUS PROVINCES (LIPs)
REGISTERED DEGREE	MSc in Gelogy
ORAL OR POSTER	Oral

Mafic-ultramafic intrusions that host magmatic Ni-Cu-Co-PGE sulfide mineralization crop out at the southwestern periphery of the 1.50-1.36 Ga Kunene Complex (KC) anorthosite in SW Angola and NW Namibia. This setting is similar to that of the world-class Voisey's Bay deposit, where Ni-Cu-Co(-PGE) sulfides are hosted within the ~1.33 Ga Voisey's Bay mafic-ultramafic Intrusion, the oldest known coeval component of the Nain Plutonic anorthosite Suite (1.36-1.29 Ga). Unlike the Voisey's Bay Intrusion, the temporal relationship between the KC and its peripheral intrusions remains unresolved. Previous geochronological studies have produced a wide range of conflicting ages, including Ohamaremba (1.22 Ga, ~1.40 Ga, 1.75-1.72 Ga), Otjijanjasemo (1.76 Ga), Ombuku North (~1.35 Ga), and Ombuku South (1.72 Ga), interpreted to reflect processes such as inheritance, crystallization, or resetting. This study proposes to use field relationships, structural analysis, and geochronology to better constrain the emplacement age of Ombuku South and Otjijanjasemo intrusions. Structural geology results indicate that the N-S trending Ombuku South and E-W trending Otjijanjasemo intrusions were emplaced during or after a newly recognized regional E-W shortening event. This event, which has a minimum age of 1.75 Ga, produced steep, N-S striking stromatic foliations in the country rocks of both intrusions. Subsequently, the Ombuku South intrusion was emplaced along this foliation, a relationship evidenced by its distinct sub-vertical, N-S striking compositional layering characterized by alternating cm-scale bands of anorthosite and norite. The minimum age of 1.75 Ga for this shortening event is based on a dated granite intrusion within the Ombuku South country rocks that was deformed by the shortening. The Otjijanjasemo intrusion, unlike Ombuku South, did not intrude along the N-S foliation of its country rocks, suggesting a later emplacement or different emplacement style. Ombuku South, together with its country rocks, were subsequently heterogeneously affected by a 1.36 Ga NNW-SSE shortening event, typified by numerous cm- to m-scale shear zones, while the Otjijanjasemo and its country rocks were deformed into a gently W-plunging synform that we link to the well-documented, regional Orue upper amphibolite facies metamorphic event at ~ 1.33 Ga. This folding is likely of regional significance and is compatible with the discrete shear zones of the Ombuku South area. Integrated structural and geochronological data bracket the emplacement age of the Ombuku South intrusion between 1.75 and 1.36 Ga and confirm that the Otjijanjasemo intrusion is older than 1.33 Ga. An even older minimum age of >1.73 Ga is suggested for Otjijanjasemo by a 1.73 Ga granodiorite.

TITLE	**Constraining the Magma Sources and Tectonic Setting of the Kunene AMCG Complex**
PRESENTING AUTHOR	**Kaydi Govender**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	2332536@students.wits.ac.za
SUPERVISOR/S NAME/S	Prof Grant Bybee, Dr Trishya Owen-Smith, Dr Karen Smit and Prof Lorenzo Milani
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	METALLOGENY AND PALEOGEOGRAPHIC IMPLICATIONS OF LAYERED IGNEOUS COMPLEXES (LICs) AND LARGE IGNEOUS PROVINCES (LIPs)
REGISTERED DEGREE	MSc
ORAL OR POSTER	ORAL

Proterozoic massif-type anorthosites are usually associated with coeval silicic rocks, making up the anorthosite-mangerite-charnockite-granite (AMCG) suite. The petrogenesis of AMCG rocks is still unresolved, with isotopic and experimental data supporting mantle and/or crustal sources. Our study focuses on the Mesoproterozoic (1.50–1.38 Ga) Kunene AMCG Complex (KC), which stretches from NW Namibia to SW Angola, spanning approximately 53 500 km^2, making it the largest Proterozoic anorthosite complex globally (Drüppel et al., 2000, Gleißner et al., 2011, Rey-Moral et al., 2022, Mochales et al., 2025). The Red Granite Suite (RGS) is a felsic suite covering over one-third of the KC and, therefore, warrants an investigation into its petrogenetic relationship with the Kunene anorthosites.

My study aims to determine the parental magma source/s and tectonic setting of the KC by combining Sr, Nd, and Hf isotopic compositions with stable K isotopic compositions of 24 samples composed of anorthosites and coeval granitoids. Potassium isotopes are of particular interest due to their recent proposal as a tracer of sources and transport of fluid-mobile, incompatible elements in subduction zones (Wang and Ionov, 2023). Sediments and the altered oceanic crust are both enriched in K_2O (0.41–1.15 wt %, Hu et al., 2020), whereas the overlying melt-depleted lithospheric mantle is low in K_2O (around 0.2 wt %, White and Klein, 2014). This difference in K concentration between crustal and mantle lithologies potentially makes K isotopes a sensitive tracer of slab-to-mantle wedge fluid transfers (Wang and Ionov, 2023; Tian et al., 2024).

Preliminary trace element results show significant variation in chondrite-normalised HREEN among anorthositic samples, which will be further investigated through isotopic analysis. The chondrite-normalised REE diagram reveals LREEN enrichment, HREEN depletion, and positive Eu anomalies (Eu/Eu^*: 1.71—15.3), indicative of plagioclase accumulation, consistent with the high plagioclase content in these anorthosites. Granitoids also display LREEN enrichment and HREEN depletion but with negative Eu anomalies (Eu/Eu^*: 0.13 — 1.04), reflecting feldspar fractionation.

Isotopic analyses show that the anorthosite suite has enriched Sr and Nd isotopic signatures characterised by variable εNd values (-14.8 to 2.7), relative to CHUR at rock age) and 87Sr/86Sr ratios relative to Bulk Silicate Earth at rock age (BSE; Gray et al., 1973), ranging from 0.7029 to 0.7054. On the other hand, isotopic analyses of the granitoids has enriched Sr and Nd isotopic signatures characterised by negative εNd values (-5.9 to -1.3, relative to CHUR at rock age) and variable 87Sr/86Sr ratios relative to Bulk Silicate Earth at rock age (BSE; Gray et al., 1973), ranging from 0.7003 to 0.7058. Furthermore, Kunene granites display variable εHf values (-20.1 to -6.4, relative to CHUR at rock age). Comparing these isotopic systems of KC anorthosites and granites with known mantle and crustal reservoirs, suggests that the KC originated from an enriched mantle source that interacted significantly with crustal material. This likely resulted from either recycled crustal material or oceanic crust subduction, which introduced ancient components into the asthenospheric mantle (Milani et al., 2022).

Whereas radiogenic isotopes define a mantle source with crustal contamination, K isotopic results are expected to be more sensitive to the input of subduction-derived components (Wand and Ionov, 2023). The acquired $\delta^{41}K$ values of the analysed samples tend to have variable ranges, the anothosites range from -0.67 to 0.44 and the granites range from -0.74 to -0.2. The extremely negative values in the granites are suggested to have been influence by weathering processes.

By integrating traditional Sr-Nd-Hf isotopes with K isotopes, our study aims to refine our understanding of Kunene magmatism and assess the role of subduction in its formation. Furthermore, if K isotopes fingerprint oceanic sediments, there may be a possible link to mineralisation associated with subduction environments. The integration of these methods within a multidisciplinary framework is expected to significantly advance our understanding of the Kunene Complex and establish a more comprehensive comparative database for future research.

REFERENCES

Bybee, G.M., Hayes, B., Owen-Smith, T.M., Lehmann, J., Ashwal, L.D., Brower, A.M., Hill, C.M., Corfu, F., and Manga, M., 2019. Proterozoic massif-type anorthosites as the archetypes of long-lived (100 Myr) magmatic systems—new evidence from the Kunene Anorthosite Complex (Angola). Precambrian Research 105393.

Drüppel, K., Littmann, S., and Okrusch, M., 2000. Geo-und isotopenchemische Untersuchungen der Anorthosite des Kunene-Intrusiv-Komplexes (KIC) in NW Namibia. Ber. Deutsch. Mineral. Gesellschaft, Beiheft Eur. Journal of Mineralogy, 12(1), pp. 37.

Gleißner, P., Drüppel, K., and Romer, R.L., 2011. The role of crustal contamination in massif type anorthosites, new evidence from Sr-Nd-Pb isotopic composition of the Kunene Intrusive Complex, NW Namibia. Precambrian Research, 185, pp. 18–36.

Gray, C., Papanastassiou, D. and Wasserburg, G.J., 1973. The identification of early condensates from the solar nebula. Icarus, 20(2), pp.213-239.

Hu, Y., Teng, F.-Z., Plank, T., Chauvel, C., 2020. Potassium isotopic heterogeneity in subducting oceanic plates. Science Advances 6, eabb2472. https://doi.org/10.1126/sciadv. abb2472.

Milani, L., Lehmann, J., Bybee, G.M. et al. 2022, 'Geochemical and geochronological constraints on the Mesoproterozoic Red Granite Suite, Kunene AMCG Complex of Angola and Namibia', Precambrian Research, vol. 379, art. 106821, pp. 1-21, doi : 10.1016/j.precamres.2022.106821.

Mochales, T., Merino-Martínez, E., Rey-Moral, C., Machadinho, A., Carvalho, J., Represas, P., García-Lobón, J.L., Feria, M.C., Martín-Banda, R., López-Bahut, M.T. and Alves, D., 2025. Detailed in-depth mapping of the world largest anorthositic complex: Magnetic anomalies, 2.5-3D modelling and emplacement constraints of the Kunene Complex (KC), SW Angola. Geoscience Frontiers, 16(3), p.102030.

Rey-Moral, C., Mochales, T., Martínez, E.M., Lobón, J.L.G., Bahut, M.T.L., Martín-Banda, R., Feria, M.C., Ballesteros, D., Machadinho, A., and Alves, D., 2022. Recording the largest gabbro-anorthositic complex worldwide: The Kunene Complex (KC), SW Angola. Precambrian Research, 379, pp.106790.

Tian, H.C., Teng, F.Z., Chen, X.Y., Bindeman, I.N. and Ryan, J.G., 2024. Tracing island arc petrogenesis using potassium isotopes. Earth and Planetary Science Letters, 646, p.119016.

Wang, K., and Ionov, D.A., 2023. Potassium isotope evidence for slab-derived fluids in the sub-arc mantle. Earth and Planetary Science Letters, 619, 118315. https://doi.org/10.1016/j.epsl.2023.118315.

White, W.M., Klein, E.M., 2014. Composition of the oceanic crust. In: Treatise on Geochemistry. Elsevier, pp. 457–496.

TITLE	**Fe-Ti oxides as a Proxy for Metallogenic Processes in Mafic/Ultramafic Intrusions Peripheral to the Kunene AMCG Complex in Angola**
PRESENTING AUTHOR	**Goitseone Benedict Motshabi**
UNIVERSITY	University of Pretoria
EMAIL ADDRESS	u24079597@tuks.co.za
SUPERVISOR/S NAME/S	Dr Trishya Owen-Smith and Prof Lorenzo Milani
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	METALLOGENY AND PALEOGEOGRAPHIC IMPLICATIONS OF LAYERED IGNEOUS COMPLEXES (LICs) AND LARGE IGNEOUS PROVINCES (LIPs)
REGISTERED DEGREE	Master of Science in Geology
ORAL OR POSTER	Oral

The Kunene Complex is a Mesoproterozoic AMCG (anorthosite-mangerite-charnockite-granite) suite located in southern Angola and northern Namibia. Numerous small-scale mafic/ultramafic intrusions have been identified along the western and southern margins of the complex, some of them Ni-Cu-(PGE) mineralised (2,3,5). This study focuses on five intrusions in Angola, with the aim of investigating the metallogenic processes through the geochemistry of Fe-Ti oxides and characterising parageneses and textural features of possible PGE minerals. Magnetite can be a powerful tool in unravelling petrogenetic processes as it crystallises as an accessory mineral from silicate and sulphide liquids in different environments (magmatic, hydrothermal, and sedimentary) (1,2,3,5). The crystallisation environment controls the content of trace elements in magnetite (3). Petrographic observations on magnetite texture, shape, and associated minerals allowed the identification of five types of magnetite (Type 1 to 5) and this was confirmed after analyses by electron microprobe (EMPA) and laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). The ternary plots TiO2-FeO-Fe2O3 and Cr3+-Al3+-Fe3+, discriminate between magnetite sensu stricto ($Cr_2O_3 < 6$ wt%), ulvospinel, and ferritchromite. The five magnetite types have been classified into magmatic (Type 1, 2, and 3) and hydrothermal (Type 4 and 5) using the Al+Mn vs. Ti+V and V vs. Ti diagrams, with Type 1 associated with sulphides, Type 2 associated with silicates, Type 3 being ferritchromite, Type 4 being magnetite replacing sulphides, and Type 5 occurring as late-stage microveinlets (2,3,5). Additionally, Ni vs. Co diagram was used to discriminate between Type 1 and Type 2 magnetite (5).

Ilmenite associated with magnetite as discrete grains and exsolution lamellae was also analysed by EMPA, and the geochemical data of magnetite-ilmenite pairs have been used to infer the oxy-barometric conditions on cooling (5). The re-equilibration of magnetite-ilmenite pairs at decreasing temperature and oxygen fugacity shows that only some primitive magnetite crystallised above the NNO buffer.

A bright-phase mineral search was performed using the Tescan Integrated Mineral Analyser (TIMA) to identify the possible presence of PGMs and their associated mineral phases. The identified PGMs include kotulskite and mitchenerite (Bi-Te-Pd-phases) associated both with primary sulphides and secondary silicates, with the latter interpreted as derived from late-stage hydrothermal remobilisation.

REFERENCES

1. Dare, S. A., Barnes, S.-J., Beaudoin, G., Méric, J., Boutroy, E. & Potvin-Doucet, C. 2014. Trace elements in magnetite as petrogenetic indicators. Mineralium Deposita, 49, 785-796.
2. Milani, L., Oosthuizen, L., Owen-Smith, T.M., Bybee, G.M., Hayes, B., Lehmann, J., and Jelsma, H.A. 2024. Magnetite geochemistry as a proxy for metallogenic processes: A study on sulphide-mineralised mafic-ultramafic intrusions peripheral to the Kunene Complex in Angola and Namibia. Mineralium Deposita, pp. 1-29.
3. Nadoll, P., Angerer, T., Mauk, J. L., French, D. & Walshe, J. 2014. The chemistry of hydrothermal magnetite: A review. Ore geology reviews, 61, 1-32.
4. Ntuli, N. 2022. Characterisation of Platinum Group Elements in mafic/ultramafic intrusions peripheral to the Kunene Complex in Angola and Namibia. BSc Hons report: University of Pretoria.
5. Oosthuizen, L. 2023. In-situ trace element characterisation of Fe(-Ti)-oxides of the peripheral intrusions of the Kunene Anorthosite Complex. MSc dissertation: University of Pretoria

TITLE	**Tracing Magmatic Ores: Setting-up Fe-Cu-Zn Stable Isotope Methods to Trace Mineralisation in Layered Intrusions**
PRESENTING AUTHOR	**Khulekani B Khumalo**
UNIVERSITY	University of Witwatersrand
EMAIL ADDRESS	Khulekani.khumalo@wits.ac.za
SUPERVISOR/S NAME/S	Prof Grant Bybee
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	METALLOGENY AND PALEOGEOGRAPHIC IMPLICATIONS OF LAYERED IGNEOUS COMPLEXES (LICs) AND LARGE IGNEOUS PROVINCES (LIPs)
REGISTERED DEGREE	Postdoctoral Research Fellow (PDRF)
ORAL OR POSTER	Oral

Southern Africa hosts multiple Large Igneous Provinces (LIPs), both economic and non-economic - including the Bushveld LIP, the world's largest layered mafic intrusion and a globally significant repository of critical metals. Despite decades of research, there is lack of agreement regarding the origin, spatial distribution, and controls on mineralisation (Ti, V, Cr and PGEs) within the intrusion. This study seeks to address these aspects by applying non-traditional Fe, Cu, and Zn isotopes as tracers of petrogenetic processes and metal mobility. Fe-Cu-Zn isotope systems have proven useful in fingerprinting petrogenetic processes such as fractional crystallisation, magma mixing, sulphide saturation, and redox evolution as well as distinguishing contributions from mantle sources and assessing the extent of contamination. We aim to constrain the geochemical signatures of mantle-derived magmas and identify the processes that concentrated metals. Preliminary data on Upper Zone of the Bushveld LIP, analysed relative to IRMM524b (δ56Fe = 0.01 ± 0.01 ‰), show a distinct isotopic fractionation between lithologies. Massive magnetitites exhibit heavier isotopic compositions, ranging from 0.16 ± 0.01 ‰ to 0.26 ± 0.02 ‰, while the silicate-rich rocks span lighter values from -0.24 ± 0.03 ‰ to 0.02 ± 0.01 ‰. This is interpreted to reflect the influence of modal magnetite and Fe3+-bearing mineral phases during magmatic differentiation. While Fe isotope data exist for portions of the Bushveld LIP, much of it remains spatially limited or lacks higher lithological resolution across key mineralised and non-mineralised units. As such, this study focuses on the development of robust Fe isotope analytical protocols at the Wits Isotope Geoscience Laboratory (WIGL). Our current focus is on optimising the Fe isotope purification and measurement protocols using ion-exchange chromatography and multi-collector ICP-MS. Initial tests on certified reference materials demonstrate excellent column yields of at least 98.3%. Future method development will include Cu and Zn isotopes, to ultimately enable a multi-isotope approach to better resolve the genesis of mineralisation in southern African LIPs. Our contribution outlines our analytical progress, conceptual framework and invites collaboration and discussion with researchers working on layered intrusions, stable isotope geochemistry, and magmatic ore-forming systems.

Key words: Fe-Cu-Zn isotope geochemistry, magmatic ore systems, layered intrusions

TITLE	**Gold Distribution in Arsenic, Antimony-Bearing Sulphides at the Stibium Mopani Gold-Antimony Deposit, Murchison Greenstone Belt, South Africa: Evidence for Refractory Gold Mineralization**
PRESENTING AUTHOR	**Thabo S Kgarabjang**
UNIVERSITY	University of Limpopo
EMAIL ADDRESS	kgarabjangts@gmail.com
SUPERVISOR/S NAME/S	Prof Napoleon Q Hammond and Prof Axel Hofmann
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	GOLD
REGISTERED DEGREE	PhD
ORAL OR POSTER	Oral

The Antimony Line of the Murchison greenstone belt in South Africa hosts several important Au-Sb deposits, including the Beta, Athens, Monarch, and Louwskop. These deposits occur within Archaean metavolcanic and metasedimentary successions that are intruded by granitoid bodies. These ore bodies are structurally controlled along shear zones associated with extensive hydrothermal alteration. Previous studies have highlighted the complex paragenetic relationships between gold and antimony mineralisation in the belt, with mineralisation styles ranging from disseminated sulphides to quartz–carbonate–sulphide veins. Occurrence of Au is largely refractory, with very few sightings of native and fine disseminations in the past. Despite this knowledge, the precise mineral hosts of refractory Au and the mechanisms of gold deposition across these deposits are postulated to conform to conventional models of Archaean gold deposition.

This study undertakes geochemical analyses of sulphides associated with gold mineralization to investigate the distribution of gold in the associated ore minerals in samples from the Beta, Athens, Monarch, and Louwskop deposits. Primary ore minerals associated with Au and antimony mineralization include stibnite (Sb2S3), arsenopyrite (FeAsS), gersdorffite (NiAsS), ullmannite (NiSbS) and bertherite (FeSb2S4). Stibnite occurs as irregular massive crystals often with carbonate inclusions. Arsenopyrite occurs variably in the orebodies as fine and coarse euhedral to subhedral crystals, exhibiting compositional zoning in some areas. Gersdorffite and ullmannite occur as euhedral to subhedral grains with silicate and carbonate inclusions, and are frequently found within mineralised zones in association with stibnite. Trace element analysis of the sulphides using laser ablation ICP-MS reveals variable concentrations of Co, Ni, Ti, As, Ag, Au, Sb, Fe, Pb, Zn. In particular, Au concentrations in arsenopyrite, gersdorffite and ullmannite range from 0.001 to 0.02 ppm (mean = 0.006±0.007 ppm), 0.002 ppm to 0.85 ppm (mean = 0.13±0.25 ppm), and from 0.008 ppm to 9.15 ppm (mean = 1.20±1.83 ppm), respectively. The data clearly show the highest Au concentrations in ullmannite. Stibnite, arsenopyrite, gersdorffite, ullmannite and bertherite show close textural relationships, which may be consistent with the mineralising episode. However, the variable concentration may be attributed to the distinct chemical composition of these minerals. Most studies have documented that much of the "invisible gold" in arsenopyrite is incorporated into the lattice through complex crystal-chemical processes, where the gold is bound to arsenic-rich, iron-deficient sites within the arsenopyrite. On the other hand, Au occurs as nano inclusions or is absent in gersdorffite and ullmannite. At this stage, the results are consistent with refractory gold in the arsenic, antimony-bearing sulphides along the Antimony Line in the Murchshison greenstone belt, however, it is clear that gold occurs as refractory. The mode of distribution of the gold within these sulphides is yet to be validated.

TITLE	**The Tantalite Valley Complex: Insights into its Genesis and Evolution**
PRESENTING AUTHOR	**Daniel Ferreira**
UNIVERSITY	Stellenbosch University
EMAIL ADDRESS	21656118@sun.ac.za
SUPERVISOR/S NAME/S	Dr MB Klausen and Dr BP von der Heyden
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANTLE AND CRUSTAL PROCESSES, AND ASSOCIATED METALLOGENESIS INCLUDING KIMBERLITES
REGISTERED DEGREE	PhD
ORAL OR POSTER	Oral

The Tantalite Valley Complex (TVC) includes a mafic-ultramafic layered intrusion that is part of a greater Kum Kum Suite and situated in the Namaqua Sector of the Namaqua-Natal Metamorphic Province. Geochronology specifies that the TVC intruded during the early stages of the Namaqua orogeny at 1226.6 ± 3.7 Ma (Zircon) / 1219.2 ± 9.0 Ma (Baddeleyite). To date, the TVC has not been the focus of any detailed study since the 1970s, and its internal geology is therefore poorly constrained. We report that the complex is not an Alaskan-Uralian intrusion, as previously thought, but rather a composite of at least three 'nested' and stratiform layered sub-intrusions, each with its own emplacement and differentiation history. Empirical petrographic observations indicate that all intrusions are dominated by more leucocratic mafic cumulates, ranging from troctolites, (olivine) (gabbro)norites to minor anorthosites, and subordinate amounts of more melanocratic basal layers, ranging from melatroctolites to ultramafic dunites, harzburgites, and olivine orthopyroxenites. Additional cumulus mineral compositions, including plagioclase strontium isotopes, record both normal and reversed cryptic layering, where the latter is preliminarily explained by open magma chamber replenishments during ongoing gravitational crystal accumulation. While additional magma convection operated in the earliest sub-chamber, progressively smaller yet thermally more insulated sub-intrusions segregated as more stagnant chambers into basal melanocratic and upper leucocratic units. Relatively primitive parental magmas with a Mg# of up to at least 63, are represented by the TVC's most forsteritic cumulus olivine (Fo86), compared to non-cumulate marginal rocks with Mg# of up to ~66. Incompatible element signatures reveal that all three nested intrusions share similar E-MORB-like mantle source characteristics with a moderate lithospheric component, which are attributed to either crustal assimilation and/or a metasomatized lithospheric mantle (if not a nearby mantle wedge to the TVC's proposed back-arc setting). The earliest sub-intrusion is unique in that it hosts PGE-enriched sulphide showings and a thick sequence of orthopyroxene-bearing host cumulates, conspicuously absent from subsequent nested sub-intrusions. Based on stable isotopes and metal ratios, the sulphur responsible for these sulphides is clearly mantle-derived, and its immiscibility appears to be related primarily to fractional crystallization. The results of the study advance our understanding of the TVC, with implications for the genesis and metallogenic fertility of other mafic-ultramafic intrusions formed during Earth's Boring Billion.

TITLE	**Phytoremediation of Metals from Klein Letaba Gold Mine Tailings, Limpopo Province, South Africa**
PRESENTING AUTHOR	**Munyai Phumudzo Gift**
UNIVERSITY	University of Venda
EMAIL ADDRESS	munyaip@gmail.com
SUPERVISOR/S NAME/S	Dr HR Mundalamo and Prof JS Ogola
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	ENVIRONMENTAL GEOLOGY
REGISTERED DEGREE	PhD
ORAL OR POSTER	Oral

Phytoremediation is an environmentally friendly technique that uses green plants to reduce, remove, or stabilise environmental toxins, particularly those of anthropogenic origin. It is cost-effective, aesthetically acceptable, and less disruptive compared to conventional methods such as excavation or chemical stabilisation. Its main applications include accelerating degradation of organic contaminants through rhizosphere microorganisms and removing toxic metals from soils and water.

The Giyani Greenstone Belt is historically known for gold mineralisation, with mining operations at Klein Letaba, Louis Moore, Birthday, Golden Osprey, and Fumani. Although these mines are now closed, their tailings dams contain metals that pose serious environmental and health risks. This study investigated the Klein Letaba Tailings Dam, which contains Pb, Zn, Cu, As, Ni, Cd, and traces of Au.

Fieldwork involved geobotanical mapping, geochemical survey, and pot-culture experiments. Eighty plant and tailings samples were collected based on abundance, with tailings sampled at the same locations as plants. Laboratory analyses were conducted at the University of Venda and Madzivhandila College of Agriculture. Pot experiments at the South African National Biodiversity Institute (Thohoyandou Botanical Garden) used 14 trays to mimic natural conditions over a 7-month growth period, followed by 4 months of harvesting. Metal concentrations were determined, using ICP-OES, and data were processed using Excel, ArcGIS, and Kriging.

Three dominant native species, Combretum imberbe, Cynodon dactylon, and Sporobolus africanus were identified. Tailings samples contained elevated concentrations of Pb (11,886 ppm), Ni (2,049 ppm), As (1,276 ppm), Cr (1,271 ppm), Zn (695 ppm), and Cu (140 ppm). Pot experiments showed that Combretumimberbe effectively accumulated Cu, Pb, and Zn in roots (>7 ppm Cu; >6 ppm Pb), while Sporobolus africanus concentrated Cr (7.8 ppm), As (6.6 ppm), and Pb (6.5 ppm). Uptake was generally higher in roots than shoots, suggesting stabilisation rather than translocation.

The study also assessed phytomining potential. Combretum imberbe showed promise for above-ground harvesting, recording Zn (~8 ppm), Fe (~10 ppm), and Cu (~5 ppm) in aerial tissues. Sporobolus africanus complemented this with stabilisation of Mn and Fe. Low Cd and As uptake reduced risks of secondary contamination. Given current market values (Pb ~$1.95/kg, Cu ~$4.83/kg, Ni ~$7.11/kg, Mn ~$1.55/kg, Zn ~$2.82/kg), metal recovery through phytomining could provide economic benefits alongside environmental rehabilitation.

Overall, the findings highlight the potential of native species to stabilise and remediate metal-contaminated tailings, while also enabling recovery of valuable elements. This strategy supports global sustainability goals by promoting safer ecosystems, cost-effective remediation, and opportunities for land rehabilitation in mining-impacted regions.

Keywords: Phytoremediation, Phytomining, Klein Letaba Tailings Dam, Native Plants, Metals

TITLE	**Experimental investigation of Bushveld Chromitite Formation II: The Story from Sintered Olivine Capsules**
PRESENTING AUTHOR	**Dr Tahnee Otto**
UNIVERSITY	Stellenbosch University
EMAIL ADDRESS	tahneeotto@sun.ac.za
SUPERVISOR/S NAME/S	Prof Gary Stevens
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	METALLOGENY AND PALEOGEOGRAPHIC IMPLICATIONS OF LAYERED IGNEOUS COMPLEXES (LICs) AND LARGE IGNEOUS PROVINCES (LIPs)
REGISTERED DEGREE	Postdoctoral Research Fellow (PDRF)
ORAL OR POSTER	Oral

How much chromium (Cr) was dissolved in the melts that formed the Rustenburg Layered Suite (RLS), whether chromite crystals were part of the magmas that intruded to form the RLS, and how Cr solubility of the melts changed after intrusion are critical questions for understanding the uniquely rich and extensive chromitite deposits of the RLS. This study has investigated Cr-solubility in water-bearing mafic melts under relatively oxidized conditions (~ΔQFM+3) in the mid-crust using capsules constructed by sintering peridotite-derived olivine aggregate at 1350 °C. This negates the need to use noble metal capsules with graphite liners but does force olivine saturation. A Karoo picrite was used as the starting composition (Table 1). The experiments were conducted in a non-end loaded 13 mm piston cylinder apparatus at 7 kbar and show that melt co-exists with olivine and spinel at 1200 ºC, and with olivine, spinel, orthopyroxene, and clinopyroxene at 1150 ºC. These melts contain 0.04 and 0.03 wt.% Cr_2O_3, respectively. The results indicate that, due to the inverse correlation between Cr solubility and oxygen fugacity (fO_2), the majority of Cr (91-93% of that contained in the starting material) resides in the crystal phases, with minimal variation due to temperature, within the narrow band investigated. The temperature of the liquidus was not constrained.

In combination with the findings of Stevens and Otto (this volume), which demonstrate that in similar melt compositions under more reducing conditions, Cr_2O_3 solubility exceeds 0.85 wt% at ~1300 ºC, these findings demonstrate that in-chamber oxidation of relatively reduced mantle derived magmas can produce sufficient chromite in a crustal magma chamber to account for that observed in the RLS. Specifically, the findings demonstrate that a 20 m thick sill could precipitate a chromitite layer approximately 30 cm thick. There is no chromite budget problem in the RLS. However, whether a significant proportion of chromite can precipitate without the co-crystallization of a silicate phase remains uncertain.

Table 1. Composition of the Karoo Picrite used in these experiments.

SiO_2	TiO_2	Al_2O_3	Cr_2O_3	FeO_{tot}	MgO	CaO	Na_2O	K_2O	Sum
48.76	1.46	11.69	0.46	11.25	15.73	7.26	1.69	1.71	100.00

TITLE	**Tectonic Processes Affecting the Central Kaapvaal Craton: Evidence from Mesoarchaean TTGs from the Johannesburg Dome**
PRESENTING AUTHOR	**Fezeka Gugulethu Dliwako**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	2320205@students.wits.ac.za
SUPERVISOR/S NAME/S	Dr Karen Smit and Dr Linda Iaccheri
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANTLE AND CRUSTAL PROCESSES, AND ASSOCIATED METALLOGENESIS INCLUDING KIMBERLITES
REGISTERED DEGREE	MSc in Geology
ORAL OR POSTER	Oral

The study presents the findings of a geochronological and the first-ever isotopic studies of the Nooitgedacht platform rocks. The Nooitgedacht platform is located in the heart of the Kaapvaal craton, at the Johannesburg Dome, where an inlier exposing well-preserved Archaean crust exists. The Archaean crust is composed of a TTG gneiss suite, along with associated amphibolites and mafic dykes. This study builds on the work by Anhaeusser (1999), where a high-resolution map was produced and detailed geochemical analyses were presented, drawing upon related geochronological studies to provide age constraints for the Nooitgedacht platform and the broader Johannesburg Dome. The Nooitgedacht Platform rocks define a calc–alkaline series characterised by a decrease in MgO, FeO, CaO, and TiO2 as SiO2 increases. There is an increase in SiO2 with an increase in Na2O and K2O, while Al2O3 shows weak to moderate correlations. TTGs of the Barberton Granitoid–Greenstone Terrain (BGGT) also define a calc–alkaline series. REEN patterns of the Nooitgedacht Platform rocks are defined by consistent LREEN enrichment and variable HREEN depletion, with overall less enriched LREEN and relatively flat HREEN relative to the East Pilbara Terrane rocks, with 2 samples (a leucogranodiorite and a dioritic and tonalitic gneiss) showing heterogeneity through yielding flat patterns. New U–Pb zircon data were obtained in this study to build up on the geochronological data of the central Kaapvaal Craton and whole-rock new isotopic studies from the Lu–Hf, Rb–Sr and Sm–Nd systems. The crustal U–Pb zircon ages are compared to mantle peridotite Re-Os TRD ages of the central Kaapvaal craton to complete a slice of the lithosphere through the centre of the craton and to assess whether there is coupling or decoupling of the crust and mantle through time. The dioritic and tonalitic gneisses (3211.9 ± 6.5 Ma) are the oldest rocks of the Nooitgedacht Platform, followed by trondhjemitic gneisses (3166 ± 5 Ma), another variety of dioritic and tonalitic gneisses (3163 ± 12 Ma), and the youngest unit, trondhjemitic gneisses (3140 ± 11 Ma). The crustal ages obtained in this study align with the crustal age peaks of the Witwatersrand–Swaziland Block, particularly the 3.2– and 3.1 Ga peaks. The crustal U–Pb zircon age and mantle peridotite Re–Os TRD age peaks are predominantly offset, with only the 2.7 Ga age peak overlap. Isotopic data (Lu–Hf, Rb–Sr, Sm–Nd) from Nooitgedacht Platform lithologies reveal generally consistent, εNd(t) and εHf(t) values relative to CHUR, with variable initial 87Sr/86Sr ratios. Most rock units show matching Nd–Hf systematics, although exceptions, the leucogranodiorite and the tonalitic and dioritic gneiss noted to show varied REEN, display decoupled signatures with εNd(t) = –2.02 and εHf(t) = +15 for the leucogranodiorite and εNd(t) = +0.25 and εHf(t) = –0.9 for the dioritic and tonalitic gneiss, indicating contributions from mixed sources. Investigating the age relationships between cratonic mantle roots and their overlying crust offers key constraints on craton formation models, whether at convergent margins, within a stagnant or partially mobile lid, or influenced by plume and/or subduction processes.

TITLE	**The Metallogeny of the Mafic-Ultramafic Sithilo Complex, Tugela Terrane, Natal Metamorphic Province**
PRESENTING AUTHOR	**Nthabeleng Ramotholo**
UNIVERSITY	University of KwaZulu-Natal
EMAIL ADDRESS	216000607@stu.ukzn.ac.za
SUPERVISOR/S NAME/S	Dr Lauren Hoyer and Dr Nigel Hicks
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	BASE METALS
REGISTERED DEGREE	MSc Geology
ORAL OR POSTER	Oral

The Mesoproterozoic Sithilo Complex is a 3 km-long mafic-ultramafic segment of the Evuleka ultramafic unit in the Mandleni thrust sheet in the Tugela Terrane, Natal Metamorphic Province. Comprising serpentinised dunite, harzburgite and pyroxenite, exhibiting a cumulate sequence modified by greenschist to lower amphibolite facies metamorphism [5]. While the complex has been identified as a potential source of chromium, the mechanism of chromite formation has not been previously investigated. This study investigated the mineralogy and formation mechanisms of the Sithilo Complex, challenging the previously proposed ophiolitic origin [4];[8].

The Sithilo Complex has a lopolithic shape with inward-dipping margins and a well-defined chilled margin where in direct contact with the Wosi amphibolites of the Tugela Group. Notably, the complex is undeformed when compared with the host rock amphibolites, where the dip of the layering is titled 20° - 78° into the Sithilo Complex around the margins. Magmatic layering 1-25-m-thick, across the Sithilo Complex, reflects density-driven cumulate formation [7].

Petrographic analysis of 41 samples reveals abundant cumulate and replacement textures, with spinifex textures in olivine indicating rapid crystallization [6]. Microscopic chromite stringers within olivine-to serpentine-rich units, that have cumulate textures and sharp boundaries with euhedral to subhedral crystals, further supports a density-driven settling process within a closed magmatic system [3]. This is corroborated by 49 legacy core logs, of which 26 intersected layered and disseminated chromite ore. Chromite occurs as lenticular to nodular stringers and pods, with disseminated chromite zones ranging from 0.6 to 13.2-m-thick and seams from 0.6 to 6.7-m-thick. The chromite grades exhibit a strong correlation between Cr2O3 content (5% to 35%) and the Cr/Fe ratio (0.89 to 2.6).

Geochemical signatures, characterized by high MgO, low Al2O3, with depleted incompatible trace elements (Nb, Zr, Rb and Sr), further support closed-system fractional crystallization and distinguish the complex from mid-ocean ridge basalt magmatism [1]. The enrichment of Cr, Co and Ni aligns with the formation of a layered intrusion [2]. However, the chromite deposit lacks economical potential with Cr2O3 content at 1.72% well below the required (>38%) Cr2O3 threshold commercial threshold.

Preliminary palaeomagnetism (obtained through alternating field demagnetisation) of the pyroxenite unit indicates a stable Characteristic Remanent Magnetization direction of declination 15.1˚ and inclination 18.0˚. This confirms a consistent normal polarity with equal area projections clustering in the north quadrant with a N95 = 4.4 robust sample size.

The Sithilo Complex is unequivocally a layered intrusion, as evidenced by field observations, petrographic data, geochemistry. Its lopolithic shape, cumulate sequence, and closed-system crystallization are features characteristic of layered intrusions. While chromium content is below the economically viable threshold, this study reclassifies a significant geological formation from a previously proposed alpine-type deposit.

REFERENCES

[1] Barnes, S. J. and Roeder, P. L. (2001). The range of spinel compositions in terrestrial mafic and ultramafic rocks. Journal of Petrology, 42(12), 2279–2302.

[2] Eales, H.V. and Cawthorn, R.G., 1996. The bushveld complex. In Developments in petrology (Vol. 15, pp. 181-229). Elsevier.

[3] Irvine, T. N. (1977). Origin of chromitite layers in the Muskox intrusion and other stratiform intrusions. Geology, 5(5), 273–277.

[4] Matthews, P.E., 1972. Possible Precambrian obduction and plate tectonics in southeastern Africa. Nature Physical Science, 240(98), pp.37-39.

[5] McCourt, S., Armstrong, R.A., Grantham, G.H. and Thomas, R.J., 2006. Geology and evolution of the Natal belt, South Africa. Journal of African Earth Sciences, 46(1-2), pp.71-92.

[6] Sander, B.K. and Cawthorn, R.G., 1995. Laminated olivine spinifex textures in the Mount Ayliff intrusion, South Africa. Mineralogy and Petrology, 54(1), pp.1-10.

[7] Wager, L.R. and Brown, G.M., 1968. Layered Igneous Rocks (Oliver and Boyd, Edinburgh) pp. 588.

[8] Wuth, M.G. and Archer, P.D., 1986. Chromite mineralization at Sithilo, northern Zululand. In Mineral Deposits of Southern Africa (pp. 1689-1694).

TITLE	**Organic Petrography, Mineralogy and Sulphur Distribution Within the n0.2 Seam in the Belfast Coal Mine, Witbank coalfield, South Africa**
PRESENTING AUTHOR	**Zakhele Radebe**
UNIVERSITY	University of Johannesburg
EMAIL ADDRESS	Zakhele.radebe@exxaro.com
SUPERVISOR/S NAME/S	Dr Marvin Moroeng
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	ENERGY RESOURCES
REGISTERED DEGREE	MSc Geology
ORAL OR POSTER	Oral

Coal remains central to South Africa's energy sector, with the Witbank Coalfield playing a pivotal role due to its extensive reserves. Amongst many others in the country, Belfast Coal Mine contributes significantly to thermal coal production. The mine has experienced sulphur variations in productive the No. 2 Seam, leading to costly quality control challenges, particularly for the crush and screen plant, which is supplied as a run-of-mine product. The purpose of the research was to examine variability in the quality of the No. 2 Seam within the mine in the Witbank Coalfield, Main Karoo Basin (MKB). Five mining blocks within the Belfast Mine were selected for sampling to capture variability in quality parameters. Samples were collected from blocks with predicted low (<1 wt%) and high (>1 wt%) total sulphur (TS) contents, as well as those influenced by geological features and processes (dolerite intrusions, in seam parting and weathering). Petrographic analysis determined maceral composition and coal rank, while X-ray diffraction (XRD) identified mineral phases and X-ray fluorescence (XRF) provided elemental compositions. Proximate, ultimate, and calorific value analyses assessed the coal quality, and sulphur form analysis explored the different forms of sulphur in coals. The results enabled an understanding of the effect of the depositional environment and post-depositional processes in mineral and sulphur variability within the seam.

Typical of MKB coals, inertinite (31.8 to 89.8 vol%) was the dominant maceral group in most of the samples from the No. 2 Seam. This suggests low water-level and fire-prone paleoenvironmental conditions, periodically interrupted by higher water level and reducing periods that favoured vitrinite formation. Quartz and kaolinite dominated coal samples. Kaolinite infilled the cell lumens in organic matter, whereas quartz appeared in rounded and angular forms, indicating a detrital origin. Most carbonate minerals were epigenetic, filling fractures and cleats in the macerals. Most samples were classified as moderate-sulphur coals, with a few at the base and top of the seam classified as high-sulphur. The dominant form of sulphur was pyritic, present both in syngenetic and epigenetic forms.

The in-seam parting, reflecting flooding during peat accumulation, introduced inorganic clastic materials into the paleomire (higher ash yields), which also resulted elevated inertodetrinite and pyrite contents. Coal samples collected from the bottom and the top of the No. 2 Seam, in contact with carbonaceous siltstone, showed elevated pyrite contents compared to those bound by sandstone. The dolerite intrusion likely also introduced epigenetic minerals (carbonates and/or pyrite) due to hydrothermal fluid migration along cleats and fractures. Although the weathered samples show signs of mineral alteration, sulphur mainly exists in pyritic form, indicating limited oxidative transformation.

TITLE	**Hyperspectral Mineral Identification for Geological Mapping and REE Exploration**
PRESENTING AUTHOR	**Catherine Grobbelaar**
UNIVERSITY	University of Cape Town
EMAIL ADDRESS	GRBCAT004@myuct.ac.za
SUPERVISOR/S NAME/S	Assoc Prof Alastair Sloane
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	ENERGY RESOURCES
REGISTERED DEGREE	MSc
ORAL OR POSTER	Oral

Hyperspectral data has become increasingly available in recent years and geological surveys and consultancies have begun to use it to inform exploration and mapping campaigns. Minerals preferentially absorb light at particular wavelengths dependent on the vibrations of the chemical bonds within the mineral. The 2022 launch of the EMIT (Earth Surface Mineral Dust Source Investigation) instrument on the International Space Station combines sensitivity to wavelengths in the Infrared (IR) and Very Short Wavelength Infrared (VSWIR) fields with a ~60m spatial resolution of 285 channels between 380 and 2500 nm. Many minerals show maximum absorption in the SWIR (1000-2500 nm), VSWIR (350-2500 nm) and IR (780-2500nm) spectra. The BioSCape project provides airborne hyperspectral data, collected using the AVIRIS-NG and HyTES instruments, over parts of South Africa at a finer spatial resolution than the EMIT instrument. AVIRIS-NG reflectance data is delivered as a mosaicked product at a spatial resolution of 5m with 425 channels between 380 and 2510 nm.

Case studies in North America have demonstrated the utility of combined VSWIR and IR spectrometry in geological mapping and mineral exploration (e.g. Cawse-Nicholson et al., 2019), and Tetracorder, an open-source algorithm for translating spectra into relative surface mineral abundance (Clark et al. 2003), is a powerful tool for processing this data into information relevant to mineral exploration; this process is reliant on the library of mineral spectra used. The use of satellite data for critical element exploration remains relatively underdeveloped as relatively broad wavelength, high resolution satellite instruments (EMIT) have only come online recently.

This project seeks to provide proof-of-concept that these data sets can provide information valuable for mineral exploration, with a particular focus on REE-enriched carbonatites which have been shown to display characteristic absorption at wavelengths around 744 and 802 nm. In geological mapping there can be compositional variation within geological units which hyperspectral mineral mapping can refine. Hyperspectral mineral mapping using space-borne and airborne data assesses the critical zone for the distribution of mineral nutrients; this biogeochemistry at the surface is important for biodiversity and biological applications. In the same way, hyperspectral mineral mapping can be used in exploration to assess carbonatites for critical minerals and their estimated abundance.

TITLE	**Premier kimberlite cluster megacrysts: constrains on kimberlite melt evolution in Bushveld-modified lithosphere**
PRESENTING AUTHOR	**Khethukuthula Ndebele**
UNIVERSITY	University of Cape Town
EMAIL ADDRESS	NDBKHE003@myuct.ac.za
SUPERVISOR/S NAME/S	Prof PE.Janney and Dr Geoff Howarth
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANTLE AND CRUSTAL PROCESSES, AND ASSOCIATED METALLOGENESIS INCLUDING KIMBERLITES
REGISTERED DEGREE	MSc
ORAL OR POSTER	Oral

Megacrysts are large (>1 cm) crystals and intergrowths found in kimberlites, which comprise of the phases olivine, clinopyroxene, orthopyroxene, ilmenite, garnet and, less commonly, phlogopite and zircon (e.g., Schulze, 1987). They can be differentiated from other mantle xenoliths based on their large grain size and chemistry (de Bruin, 1993). Eggler et al. (1979) defined two suites of megacrysts based on their Cr content, these are referred to as the Cr-poor and Cr-rich suites. There is a major controversy over the origin of megacrysts, as well their relationship with their host kimberlites.

This study aims to describe and model the petrogenetic evolution of megacrysts from the Premier (Cullinan) kimberlite by using major and trace element data obtained by in-situ methods. The Premier megacrysts being analysed are from the J.J Gurney Upper Mantle Research collection at UCT. A subset of these megacrysts was selected and thin sectioned, these have been tested for homogeneity by analysing traverses on them. The other megacryst were crushed and fresh grains were picked and mounted on 25 mm epoxy rounds. Chemical analyses on both the polished mounds and thin sections are being performed on JEOL JXA-iSP100 electron microprobe for major elements and Applied Spectra 193 mm excimer laser ablation system coupled to a Thermo iCAP-RQ quadrupole ICP-MS for trace elements, all at UCT.

The Premier kimberlite (1153.3 ± 5.3 Ma) penetrates the 2056 Ma Bushveld Igneous Complex (Tappe et al., 2021) in the central Kaapvaal craton, part of a cluster of 5 kimberlites. The Bushveld Igneous complex has been invoked by several studies to account for the relatively fertile nature of the Kaapvaal mantle lithosphere beneath Premier. At least three distinct compositional groups of clinopyroxenes from the Premier cluster were defined by de Bruin (1993) based on Ca#, Mg# and Cr content. Our new data reinforce, but also extend the compositional and temperature-pressure ranges previously established for Premier group megacrysts.

Chemical analyses of megacrysts done in this study will help constrain their petrogenesis and aid investigation of the local lithospheric mantle . Comparison with data from other kimberlites (southern African and worldwide) will be used to show the effect (if any) of the Bushveld Igneous Complex on the Kaapvaal mantle lithosphere.

TITLE	**Remote Sensing and Structural Geology of the Rooikuiseb Anticlinorium in the Southern Central Zone, Damara Belt, Namibia**
PRESENTING AUTHOR	**Atavile Ximbi**
UNIVERSITY	University of Johannesburg
EMAIL ADDRESS	atavileximbi@gmail.com
SUPERVISOR/S NAME/S	Prof Jérémie Lehmann and Dr Robyn MacRoberts
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANTLE AND CRUSTAL PROCESSES INCLUDING KIMBERLITES
REGISTERED DEGREE	MSc
ORAL OR POSTER	Oral

The NE-trending Damara Belt formed during the collision of the Congo and Kalahari cratons between 590 and 470 Ma. The Rooikuiseb Anticlinorium (RK) is a regional structure in the southern Central Zone (sCZ) of the Damara Belt. The deformation record of regional-scale dome structures in the sCZ has either been reconciled into a single phase of progressive deformation or multiple phases of deformation, due to differing structural inventories of the domes and different interpretations of the deformation structures. The study aims to unravel the structural evolution of RK and gain a better understanding of the different mechanisms for doming in relation to the tectonometamorphic evolution of the orogen. Additionally, the stratigraphy of the northern RK is investigated using remote sensing and field mapping. Ground-truthed Landsat 8 False Colour Composite, Band ratio, and Principal Component Analysis remote sensing maps and field mapping reveal the stratigraphic units of the Neoproterozoic Damara Supergroup at RK include the Etusis, Tinkas, and Karibib formations, from the base upwards. The metamorphic conditions of deformation are supra-solidus, upper amphibolite facies, with garnet, biotite, sillimanite, and cordierite assemblages, and the presence of leucosomes that indicate melt was present during at least the main deformation event (D1). Structural mapping reveals two deformation events, D1 and D2. D1 structures include shallow-dipping metamorphic foliations carrying NE- or SW-trending stretching lineation, and F1 recumbent isoclinal folds. Common mesoscale antithetic slip dilational domino boudinage, sigmoid-shaped lenses, and microscale polycrystalline quartz clasts demonstrate top-to-SW shearing during D1. Regionally, D2 is partitioned into (i) pure-shear dominated, 10 km-scale folding of D1 structures that gave rise to the shallowly NE-plunging 10 km-scale RK anticline, with broadly steep NW- and SE-dipping limbs, and (ii) dextral strike-slip shearing ocalized in m-wide ESE-striking leucogranitic dykes. Locally, D2 produced a mesoscale Type 3-fold interference pattern between F1 recumbent and F2 inclined folds. D2 operated under NW-SE shortening and is related to the main collision between the Congo and Kalahari cratons. The deformation record of the RK has been reconciled into multiphase deformation based on the interpretation of its structural inventory. However, the origin of D1 recumbent folding and associated with top-to-SW shearing is still unknown and is the focus of ongoing work.

TITLE	**Insights into Mantle Processes of the Cullinan Kimberlite (previously Premier Kimberlite) Pipe, Kaapvaal Craton, South Africa**
PRESENTING AUTHOR	**Chanelle du Plessis**
UNIVERSITY	University of Pretoria
EMAIL ADDRESS	chanelleduplessis1220@gmail.com
SUPERVISOR/S NAME/S	Prof Nils Lenhardt and Prof Lorenzo Milani
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANTLE AND CRUSTAL PROCESSES INCLUDING KIMBERLITES
REGISTERED DEGREE	MSc Geology
ORAL OR POSTER	Oral

The Cullinan kimberlite (formerly the Premier kimberlite), located on the western margin of the Kaapvaal craton, is one of the most economically significant diamondiferous intrusions globally and provides a key natural laboratory to investigate mantle processes. Kimberlites are volatile-rich ultramafic magmas that entrain mantle xenoliths and xenocrysts, offering insights into deep mantle composition, metasomatism, and the conditions of diamond stability (Agashev et al., 2008; Gernon et al., 2023). Despite extensive study, uncertainties remain regarding the heterogeneous mantle sources and metasomatic events that contributed to Cullinan's magmatic evolution and diamond population (Tappe et al., 2020; Dongre & Tappe, 2019).

This study integrates petrography, major- and trace-element mineral chemistry, and preliminary geothermobarometric constraints from four kimberlite types at cullinan: Fawn, Pale Piebald, Blue, and Black Transitional. Representative samples were processed through mineral separation, followed by electron microprobe analysis (EMPA) and laser ablation ICP-MS (LA-ICP-MS) of garnet, clinopyroxene, olivine, amphibole, phlogopite, and serpentine.

Petrographic observations reveal pervasive alteration across all varieties. Olivine is wholly serpentinized, while sodic clinopyroxene and interstitial phlogopite record alkali-rich metasomatism (Giuliani et al., 2020; Howarth et al., 2022). Garnets occur as xenocrysts with zoning and resorption textures, indicating derivation from the lithospheric mantle with limited on-pipe equilibration. Mineral assemblages differ between kimberlite types: Fawn kimberlite is dominated by amphibole-rich marid-style metasomatism, Pale piebald by potassic metasomatism and garnet breakdown, while Blue and Black Transitional varieties show sodic-potassic overprints with strong serpentinization.

Bulk-rock geochemistry highlights this variability. Fawn and Pale Piebald kimberlites preserve relatively primitive ultramafic signatures, with high MgO and low Al_2O_3 contents, consistent with group i kimberlites (Le bas et al., 1986; Krmíček et al., 2021). In contrast, Blue and Black Transitional varieties exhibit elevated silica and alkalis, reflecting contamination and metasomatic enrichment. Trace element patterns and rare earth element (REE) systematics further suggest derivation from fertile to refertilized mantle lithologies.

Preliminary geothermobarometry has been undertaken using garnet and clinopyroxene compositions to provide initial pressure-temperature estimates. While detailed modelling is ongoing, the results are broadly consistent with published conductive geotherms for the Kaapvaal craton (Boyd & Nixon, 1975; Finnerty & Boyd, 1987; Rudnick & Nyblade, 1999), suggesting that Cullinan samples mantle depths within the diamond stability field.

Overall, the Cullinan kimberlite entrained material from a chemically heterogeneous and metasomatized lithosphere, where refertilization, alkali-rich fluids, and melt-rock interaction strongly influenced its mineral cargo. These results contribute to understanding mantle processes beneath the Kaapvaal craton and the complex interplay between kimberlite magmatism, metasomatic modification, and diamond stability.

TITLE	**Geological Controls on Unconsolidated Sediment and Non-Diamond Placer Distribution in the 20 to 14 A-C Diamond Concessions, Saldanha Bay to Strandfontein Shelf**
PRESENTING AUTHOR	**Jazmynn Eksteen**
UNIVERSITY	University of KwaZulu-Natal
EMAIL ADDRESS	221015247@stu.ukzn.ac.za
SUPERVISOR/S NAME/S	Prof Andrew Green
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANTLE AND CRUSTAL PROCESSES INCLUDING KIMBERLITES
REGISTERED DEGREE	MSc Geology
ORAL OR POSTER	Poster

Transhex Marine Pty Ltd has embarked on a green fields exploration program of the offshore diamond lease concessions 20 to 14. This program uses state-of-the-art geophysical and sampling equipment to establish palaeo-shoreline positions on the shelf along which placers accumulate. The previous studies of the shelf geology were compromised by low quality, low resolution data with questionable positioning. However, with new data of increased quality and positioning confidence, a robust stratigraphic model can be created that informs the controls on the distribution and concentration of economic placers on the shelf.

This project aims to study the nature and distribution of placer-bearing stratigraphic units of the South Western Cape continental shelf in concessions 20 to 14. The objectives are to 1) initiate the first high-resolution analysis of the stratigraphy using ultra-high resolution geophysical data, including TOPAS subbottom profiles, seafloor digital terrain models, side scan sonar imagery and seafloor magnetic data; 2) delineate palaeo-shorelines and erosional surfaces on which placers accumulate 3) reconcile the stratigraphic data with lithological data from RC drilling and vibracores 4) provide a geological model for the shelf that informs the nature, distribution and grade of placers, with an understanding of the controls responsible for their existence.

Initial results indicate a near complete absence of the 'Namaqua mudbelt' that was initially proposed to extend from the Orange River to Saldanha Bay. In stark contrast, sandy deposits prevail and comprise the dominant portion of the unconsolidated sediment cover. The underlying acoustic basement comprises phyllitic bedrock, truncated by a shelf-wide subaerial unconformity. Above it, a polycyclic gravel lag indicates repeated erosion and wave ravinement, with examples of gravel spits and barriers that formed at ~60 m depth, their genesis linked to a stillstand in the Younger Dryas of the Holocene. A sandy, subaqueous delta up to 8.2 m thick overlies the gravel, comprising the remnants of the Berg and Olifants River lowstand deltas. The delta front is sand-dominated, while muddy sands and muds are confined nearshore, deposited during a period of increased fluvial discharge (2.2–1.4 ka). High-energy littoral processes and northwesterly directed longshore drift have removed most prodelta muds, transporting them north. This study finds no evidence of a continuous mudbelt in the area; muddy deposits are isolated and represent a limited prodelta extension of the Olifants-Berg catchment. We thus propose the Namaqua "mudbelt" be renamed as the Berg-Olifants subaqueous delta. Such sandy materials pose excellent potential for heavy mineral placers.

TITLE	**Integrated Geometallurgical and Mineralogical Assessment of Vanadium in Magnetite of the Upper Zone in the Bushveld Complex**
PRESENTING AUTHOR	**Liseloane Lucia Malelu**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	746283@students.wits.ac.za
SUPERVISOR/S NAME/S	Dr Leonidas Vonopartis, Prof Judith Kinnaird and Dr Raimon Tolosana-Delgado
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	BASE METALS
REGISTERED DEGREE	Doctor of Philosophy in Economic Geology
ORAL OR POSTER	Poster

The 2.06 Ga Bushveld Complex is one of the largest sources of vanadium deposits, hosted within the titaniferous magnetite-rich layers of the Upper Zone of the Rustenburg Layered Suite. Understanding the spatial variability of vanadium within these layers, as well as the textural features, provides insights to enhance the efficiency of V-extraction. We report preliminary results of integrated geometallurgical knowledge and mineralogical analysis of the mine face, drillcore and processing plant samples at Vamecto mine, situated in Brits, North West Province, South Africa, in the Western Limb of the Bushveld Complex.

The titanomagnetite layers are divided into three seams that strike east-west with dips of 15 to 20° to the north. These seams are located at a maximum depth of 130 m, 200 m and 270 m below the surface and are interlayered with gabbro, gabbronorite, and anorthosite. The field observations in the region include several fault zones associated with pervasive alteration, mostly affecting the top lithological units, anorthosite layers and along lithological contacts. Haematization occurs as partings along lithological contacts of titanomagnetite layers. Petrographic analysis reveals that magnetite occurs in two primary forms with ultrafine textures, distinguished by the presence or absence of inclusions. X-ray diffraction confirms the occurrence of both magnetite and maghemite, while electron probe micro-analyzer elemental mapping indicates that inclusion-bearing magnetite contains higher concentrations of Fe, V, and Cr compared to inclusion-free magnetite. Magnetite also display an array of fine-grained intergrowths and exsolution textures of ilmenite and spinels, which are depleted in V and enriched in Ti; however, the V content is enhanced at the grain boundaries between ilmenite and magnetite. Ilmenite grains occur as granular intergrowths, while the spinels exhibit a variety of textures: trellis, lenticular lamellae, exsolution rims, cubic, and cloth-texture type.

The whole rock V concentrations identified down the stratigraphy increase from 7,000 to 9,170 ppm V in titanomagnetite, approximately 4,740 ppm in partings, and between 50 and 220 ppm in interlayered rocks. The dominant host for vanadium is magnetite, but preliminary results show minor concentrations in silicates, particularly clinopyroxene, which contributes to grade heterogeneity across the orebody.

The results show that the occurrence of diverse exsolution textures in titanomagnetite has implications on vanadium deportment. These textures formed under variable physicochemical conditions, with vanadium partitioning strongly influenced by oxygen fugacity and mineral–melt equilibria. Also, the enrichment of vanadium down the stratigraphy result from diffusion-controlled in situ crystallization during magmatic differentiation.

TITLE	**Thermochemical Impact of Tectonic Processes on the Lithospheric Mantle Beneath the SE Margin of the Kaapvaal Craton: Using Mantle Xenoliths from Lesotho**
PRESENTING AUTHOR	**Puleng Nthebe**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	1520050@students.wits.ac.za
SUPERVISOR/S NAME/S	Dr. Karen V. Smit
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANTLE AND CRUSTAL PROCESSES, AND ASSOCIATED METALLOGENESIS INCLUDING KIMBERLITES
REGISTERED DEGREE	MSc
ORAL OR POSTER	Poster

The Kaapvaal Craton is one of the Earth's oldest and most tectonically stable continental cores, providing an opportunity to examine the evolution of lithospheric mantle processes. Despite its general stability, the craton has been affected by multiple tectonic and magmatic events throughout its >3.6 billion-year history.

Our study focuses on mantle xenoliths from the Letšeng-la-Terae and Thaba Putsoa kimberlites in northeastern Lesotho, located along the southeastern margin of the Kaapvaal Craton. This margin represents a transitional zone where ancient cratonic lithosphere interacts with younger orogenic and magmatic provinces, including the Namaqua-Natal Metamorphic Province and the extensive Karoo Igneous Province, which affected most of southern Africa. This setting provides ideal conditions to investigate how tectonic and magmatic events may have thermochemically modified the cratonic lithosphere. Some of Lesotho's kimberlites, particularly Letšeng, are known for producing large, high-value diamonds. Despite its economic significance, the lithospheric mantle beneath Lesotho remains less well-studied than that of other regions of the Kaapvaal Craton.

Peridotite xenoliths from Letšeng-la-Terae and Thaba Putsoa kimberlites display both granular and sheared textures. Granular peridotites exhibit coarse, equigranular textures consistent with relatively undeformed lithosphere. Sheared peridotites, in contrast, display deformation fabrics and recrystallised mineral assemblages, indicative of high-strain modification, likely linked to Proterozoic tectono-magmatic events like the Namaqua-Natal Orogeny at around 1.1 Ga (e.g., Spencer et al., 2015) or deformation along the lithosphere–asthenosphere boundary.

Ongoing analyses include characterising the major and trace element compositions of olivine, pyroxenes, and garnets to constrain xenolith paragenesis and the compositional controls on diamond stability. Garnet–clinopyroxene thermobarometry will reconstruct equilibrium pressure and temperature conditions, providing depth estimates of peridotites and defining the lithospheric geotherm at the time of kimberlite eruption. Reconstructed pressure–temperature conditions will be compared with seismic constraints on lithospheric depth across the Kaapvaal, where Fouch et al. (2004) showed that high seismic velocities associated with cold, depleted, and chemically distinct mantle extend to 250–300 km.

Isotopic analyses of Pb-Pb and Sr in clinopyroxenes, and Lu-Hf in depleted garnets, will help constrain the timing of mantle depletion and enrichment. As stated by Smit et al. (2025), peridotite rhenium-depletion (TRD) ages of the Kaapvaal craton record multiple episodes of mantle depletion and modification, with the oldest ages 3.3–3.0 Ga indicating early lithospheric stabilisation (Pearson et al., 1995; Zhang et al., 2022). Ages of 2.8–2.6 Ga reflect refertilisation during Ventersdorp plume magmatism (Gumsley et al., 2020; Khumalo et al., 2024), and 2.2–2.0 Ga ages record modification linked to the Bushveld Igneous Complex and Hekpoort LIP (Scoates & Friedman, 2008; Zeh et al., 2015; Schröder et al., 2016). Our study will evaluate whether these Lesotho xenoliths preserve a similar sequence of ages and associated depletion–enrichment processes.

Keywords: Lithospheric mantle, Lesotho, Mantle xenoliths, Kaapvaal Craton

TITLE	**Enhancing Diamond Breakage Classification using the Morphology of Natural Stones**
PRESENTING AUTHOR	**Bokani Moyo**
UNIVERSITY	University of Cape Town
EMAIL ADDRESS	MYXBOK002@myuct.ac.za
SUPERVISOR/S NAME/S	Dr Sara Burness and Michelle Brits
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANTLE AND CRUSTAL PROCESSES, AND ASSOCIATED METALLOGENESIS INCLUDING KIMBERLITES
REGISTERED DEGREE	MSc Geology
ORAL OR POSTER	Poster

Diamonds are renowned for their exceptional hardness and thermal conductivity, making them highly valued in both material science and the jewelry industry. The liberation of diamonds from kimberlite ore involves both crushing and milling. However, conventional comminution circuits that use jaw or cone crushers and autogenous mills pose a significant risk of diamond breakage due to the brittle nature of the stones upon impact. This breakage results in considerable financial losses due to the inevitable size reduction. This study addresses the critical issue of mechanical diamond breakage from conventional processing methods.

Using a donated parcel of small (<5 mm) and microdiamonds (<1 mm) from the Roberts Victor mine in South Africa, this research aims to fill the gap in literature regarding mechanical diamond breakage. Breakage severity was assessed using De Beers' breakage classification system, which distinguishes mechanical damage based on percentage mass loss. While widely adopted, this framework has notable limitations such as not explicitly correlating breakage severity with specific comminution mechanisms and uncertain whether observed fractures occur randomly or are preferentially governed by diamond morphology. This study introduces a novel analysis to the original framework that firstly characterises the diamond breakage considering diamond morphology. Additionally, links specific breakage patterns and progeny to breakage mechanisms.

The first phase involved the initial characterisation of the diamond parcel. A total of 6228 stones were sorted based on morphology, identifying four distinct types: octahedral (n=1192), dodecahedron (n = 14), macles (n = 167), and tetrahexahedra (n = 677). Light microscopy, scanning electron microscopy, and micro-computed (micro-CT) tomography were used for detailed characterisation of the diamonds, enabling examination of inclusions, colour, and surface features. Micro-CT, further allowed identification of breakage planes in relation to crystallographic orientations.

Results reveal that irregular breakage occurs 82% more frequently in secondary morphologies than in primary morphologies. Inclusions play a decisive role: in primary morphologies, inclusions caused irregular fracture propagation in 58% of cases, while the absence of inclusions led to crystallographic breakage in more than 80% of stones. Lightly broken stones accounted for 62% of breakage in inclusion-free stones but dropped to 18% when inclusions were present. Furthermore, heavily broken stones were 2.4 times more frequent in the presence of inclusions. These findings highlight that both morphology and inclusions critically govern diamond breakage behaviour, with inclusions promoting more severe fragmentation. The refined classification scheme developed here provides new tools for monitoring and mitigating diamond damage during comminution.

TITLE	**Sulphide Paragenesis Mechanisms in the Okiep Copper Deposits, South Africa**
PRESENTING AUTHOR	**Matebello Mokoena**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	2467115@students.wits.ac.za
SUPERVISOR/S NAME/S	Dr Ben Hayes
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	BASE METALS
REGISTERED DEGREE	Master of Science by dissertation
ORAL OR POSTER	Poster

The Okiep Copper District is part of the Bushmanland Subprovince within the Namaqualand-Natal Metamorphic Province, covering an area of 60,000 km2. The Bushmanland Subprovince comprises polydeformed and metamorphosed rocks, intruded ~1060-1030 Ma by the Koperberg Suite (KBS). Copper mineralisation is associated with sulphide-bearing mafic-intermediate rocks of the KBS. The source of the magmas that formed the KBS between 1060 and 1030 Ma is thought to be the mantle, with subsequent contamination by enriched lithospheric or crustal material. It has also been suggested that the KBS could have resulted from partial melting of the crustal rocks. The KBS occurs as a swarm of some 1700 irregular and discontinuous sheet- and plug-like bodies, that show a close relationship with "steep structures". The "steep structures" are described as narrow, east-northeasterly-trending zones characterised by high strains displaying antiformal cusp-like geometries.

Despite its extensive history of copper extraction, the origin of the KBS copper deposits within the Okiep Copper District and the mechanisms of concentration of the primary magmatic sulphides in the KBS are poorly understood. The sulphides are generally regarded as being magmatic in origin, similar to a classic magmatic Ni-Cu-PGE sulphide system; however, some authors argue that the Okiep ore bodies are possibly an endmember of the Iron Oxide Copper Gold (IOCG) mineral system, with the sulphides being formed from late-stage, magmatically derived hydrothermal fluids and that the Okiep ore bodies were affected by metamorphism, thus undergoing extensive oxidation. As such, the Okiep copper ore bodies are not easily explained by current mineral deposit classification schemes.

A means to better understand the paragenesis of sulphide melts in this deposit can be achieved using in situ trace element composition of sulphide minerals, as this can provide information about how the sulphide melt formed and evolved within the magmatic system. This new geochemical tool allows for texturally constrained models for sulphide paragenesis to be developed. In this project, petrogenetic and in situ trace element compositions of the sulphides in the Cu-rich deposits of the Okiep Copper District, taken by the LA-ICP-MS, will be characterised and compared. The paragenesis of the sulphide melts will be determined, and an attempt to establish the causes of Cu-enrichment in the Okiep Copper District will be made, providing new insights into the origin of these Cu-rich Okiep deposits.

TITLE	**Detailed Bedrock Morphology and Structural Geology Controls on Diamond Traps Offshore Hottentot's Bay, Southern Namibia**
PRESENTING AUTHOR	**Ishta Maharaj**
UNIVERSITY	University of KwaZulu-Natal
EMAIL ADDRESS	221006806@stu.ukzn.ac.za
SUPERVISOR/S NAME/S	Dr Lauren Hoyer and Prof Andrew Green
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	OTHER (ALLUVIAL DIAMONDS)
REGISTERED DEGREE	MSc in Geological Sciences
ORAL OR POSTER	Poster

Gemstone quality diamonds off the coast of Namibia are some of the best quality stones in the world, significantly contributing to the blue economy of southern Africa. Offshore Hottentot's Bay, Namibia, an inner continental shelf occurs with outcrops of schists, phyllites and gneisses of the Gariep Belt as well as Precambrian gneisses and schists of the Namaqua Metamorphic Complex. The deformation of these rocks has produced a structurally complex morphological pattern that controls the distribution and accommodation of sediment along the shelf. Overlying the basement, gravel beds occur that are endowed with alluvial diamonds eroded from kimberlites of the Kaapvaal Craton that have been transported to the shelf via the Orange-Vaal catchment.

The strong correspondence between gravel and diamonds along the continental shelf indicates the presence of gravel as a proxy for diamondiferous zones. However, the exact relationship between the underlying bedrock structures and gravel accumulation (and thus diamond concentration) is poorly understood. This project aims to rigorously test this relationship using machine learning techniques. Machine learning is a form of artificial intelligence (AI) that allows a computer to analyse statistical datasets to identify patterns and make accurate predictions about new data. Supervised learning, a type of machine learning, trains a model to predict the correct output for a given input. The trained model can then be applied to larger quantities of data. Using machine learning techniques, the correspondence between a variety of bedrock structures with gravel accumulation and stone frequency will be tested. A genetic model for trapping efficacy and stone quantity can then be generated, a first for southern African offshore placer resource estimation.

Analyses of ultra-high resolution geophysical data collected by the ML103A Mine operated by the Trans Hex Group involved manual digitisation of bedrock structures, including joints, faults and foliation patterns as well as their relative movements during deformation. The data include densely spaced (50 x 50 m) multichannel TOPAS sub-bottom profiles, 0.5 m x 0.5 m resolution digital terrain models (DTM) of the seafloor, and side scan sonar imagery of the seafloor at a resolution of 0.25 cm x 0.25 cm. The primary layering of the bedrock displays a predominant north-south trend. Faults and fractures cut through these structures, resulting in offsets, rotation and segmentation of the layering. The formation of fault duplexes and splays resulted in significant fault drag and curving of primary layers to produce valuable kinematic indicators. The interpretation of deformation events that produced these structures will be conducted and validated using published onshore data. Gravel distributions, as inferred by geophysical prospecting, in addition to > 9000 boreholes at a 50 m x 50 m grid will be analysed and the most appropriate model for the data will be selected to allow for the analysis of the relationship between bedrock structures and diamond concentrations and/or grade using supervised machine learning techniques. This will produce a more detailed prospectivity pattern to focus the target and extraction processes undertaken by the mine to those areas with the highest diamond concentrations and/or grade.

TITLE	**Thermal Maturity History and Hydrocarbon Generation Modelling within The Southern Pletmos Sub-Basin, Offshore South Africa**
PRESENTING AUTHOR	**Dr Fritz A Agbor**
UNIVERSITY	University of the Western Cape
EMAIL ADDRESS	2947208@myuwc.ac.za
SUPERVISOR/S NAME/S	Jan Van Bever Donker
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	ENERGY RESOURCES
REGISTERED DEGREE	Postdoctoral Research Fellow (PDRF)
ORAL OR POSTER	Poster

The Pletmos sub-basin, situated within the Outeniqua Basin, offshore South Africa, developed through a dynamic interplay of tectonic (rifting, dextral-, and strike-slip deformation) and sedimentation processes. The sub-basin has an intricate structural and sedimentary basin-fill history, influenced by attendant regional thermal regimes and multi-staged evolutionary processes. The primary delineating components, namely the Superior, Pletmos, and Plettenberg faults, define limits of rift sedimentation, separating the basin into two (viz Northen and Southern) major depocenters. This study employed an integrated approach, combining geological and geochemical data alongside 1D basin modelling techniques. The focus lies on investigating burial and thermal maturity histories, the timing of hydrocarbon generation, and expulsion from Mesozoic siliciclastic fine-grained clay-rich formations (viz Kimmeridgian, Valanginian, Hauterivian, Aptian, and Turonian) within the southern depocenter of the sub-basin. Source rock burial histories at designated well locations were modelled, with the subsequent simulation of thermal and maturation. The models were calibrated using vitrinite reflectance data from six offshore wells and constrained by paleo-temperature, heat flow, and kinetic parameters.

The modelling results reveal increasing source rock maturities from the fault-bound Superior High in the north towards the south of the study area. Generally, present-day maturities range from immature to late mature (dry gas), progressively from the Turonian to the Kimmeridgian following transformation ratios (TR). The Kimmeridgian shows the highest TR, followed by Aptian and Valanginian source rocks, while Turonian source rock remains largely immature. Three main stages of generation (~ 132-89 Ma, ~ 89-45 Ma, and ~ 45 Ma to present-day) have been predicted, and the critical moment is proposed to be ~ 23 Ma (Oligocene). Petroleum generation is modelled to have commenced at ~ 135 Ma. This implies that production preceded reservoir charging, believed to have primarily occurred during the Cenozoic.

TITLE	**The Iron Formations of the Eastern Mesoproterozoic Aggeneys Terrane, and their Significance to Zn-Pb Deposits**
PRESENTING AUTHOR	**Wayne Nel**
UNIVERSITY	University of Free State
EMAIL ADDRESS	NelWJ@ufs.ac.za
SUPERVISOR/S NAME/S	Wayne Colliston
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	MANGANESE AND IRON ORE
REGISTERED DEGREE	PhD
ORAL OR POSTER	Poster

Within the Mesoproterozoic Aggeneys Terrane, distinctive iron-rich garnet quartzites occur in both the upper Gams Formation and lower Wortel Formation of the Bushmanland Subgroup in the western terrane. In the eastern Aggeneys Terrane, similar iron-rich units are present within several Wortel-type sequences. In the west, these rocks are particularly significant as they are spatially associated with major Zn-Pb massive sulphide deposits at Gamsberg and Black Mountain mines within the western Aggeneys Terrane.

The iron-rich units represent important stratigraphic markers and have exploration significance for Zn-Pb mineralisation across the Aggeneys Terrane. However, their presence does not always correlate with major ore bodies—for example, the lower Wortel Formation in the western terrane hosts iron-rich quartzites but lacks large Zn-Pb deposits. Consequently, these rocks must be interpreted within their broader structural and stratigraphic framework. In the eastern terrane, where deformation is characterised by high strain and intense ductile folding, structural complexity further complicates exploration, requiring careful geological context before targeting mineralisation.

This study investigates six iron-rich garnet quartzites from different stratigraphic sequences originating from the eastern terrane and comparing them to their western counterparts in the Gams and Wortel Formations. The results reveal that the garnets are dominated by spessartine- and almandine-rich compositions. Geochemical and field evidence indicate that these iron-rich formations conform to Algoma-type banded iron formations, closely linked with exhalative-style base-metal mineralisation. Elevated manganese contents in the metamorphic minerals, the presence of barite (commonly associated with base-metal deposits), and the occurrence of gahnite—formed from the desulphurisation of sphalerite during metamorphism—further support the Algoma- type interpretation. Gahnite, in particular, is a useful indicator mineral for massive sulphide mineralisation.

TITLE	**Zircon–Baddeleyite Co-crystallisation and Accessory Phase Behaviour in Mafic Magmas: Insights from the Kunene Complex**
PRESENTING AUTHOR	**Thoriso Lekoetje**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	2119052@students.wits.ac.za
SUPERVISOR/S NAME/S	Professor Grant Bybee
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	METALLOGENY AND PALEOGEOGRAPHIC IMPLICATIONS OF LAYERED IGNEOUS COMPLEXES (LICs) AND LARGE IGNEOUS PROVINCES (LIPSs)
REGISTERED DEGREE	PhD Geology
ORAL OR POSTER	Poster

The Kunene Complex, covering more than 50,000 km² across Angola and Namibia, is the world's largest Proterozoic massif-type anorthosite. Its extensive and diverse magmatic history is recorded in a complex internal structure characterised by spatially and geochemically distinct domains. Previous studies have documented noticeable heterogeneity expressed as layers that distinguish olivine-rich from pyroxene-rich areas. In Angola, this layering creates alternating ridges and valleys of olivine- and pyroxene-bearing rocks with a mainly N–S orientation, while in Namibia, similar layers are aligned perpendicular to this trend but show a comparable topographic appearance.

In this study, we use baddeleyite to resolve high-precision age differences between lithologies and to test for systematic age variations across the northern and southern portions of the Complex. Petrographic observations, supported by cathodoluminescence (CL) imaging, reveal clear contrasts between olivine- and pyroxene-dominated lithologies. Pyroxene-rich rocks contain relatively abundant baddeleyite, displaying a wide range of morphologies and internal textures, two principal textural groups can be distinguished: (1) homogeneous grains, which appear optically uniform in Backscattered Electron (BSE) imaging and may show narrow, bright CL rims, and (2) heterogeneous grains, characterised by complex zoning, including sector zoning, patchy textures, and truncated growth domains. By contrast, olivine-rich lithologies yield far fewer baddeleyite grains. Where present, they resemble the heterogeneous group from pyroxene-rich rocks, with sector zoning, truncated internal structures, and bright CL rims. Trace element systematics in the baddeleyite further distinguish the two lithologies: pyroxene-dominated rocks generally exhibit higher LILE/HFSE ratios than their olivine-dominated counterparts. Across all samples, baddeleyite $\delta^{18}O$ values are consistently lower than both mantle values and those reported for zircon in comparable magmatic systems, ranging from –0.01 to 2.99 ‰.

Importantly, our high-precision U–Pb data reveal systematic age differences between olivine- and pyroxene-dominated lithologies, as well as between the northern and southern parts of the Complex. Moreover, baddeleyite petrochronology records contrasting histories in the two lithological groups, highlighting its utility for resolving fine-scale temporal and petrogenetic differences within large, long-lived anorthosite complexes. These data collectively indicate that the magmatic construction of the Kunene Complex was neither instantaneous nor uniform but instead protracted and spatially variable.

TITLE	**Mineralogical and Petrogenetic Characterization of Witkop Pegmatites, Northern Cape, South Africa**
PRESENTING AUTHOR	**Masonwabe Jubase**
UNIVERSITY	University of the Witwatersrand
EMAIL ADDRESS	1053004@students.wits.ac.za
SUPERVISOR/S NAME/S	Dr Nonkuselo Madlakana
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	CRITICAL RAW MATERIALS
REGISTERED DEGREE	MSc
ORAL OR POSTER	Poster

Pegmatites crystallize from highly evolved, volatile-rich felsic melts and are important hosts of critical metals such as Li–Cs–Ta (LCT) and rare earth elements (REEs). Their origin, however, remains debated: either through extreme granite fractionation or partial melting of metasedimentary rocks during metamorphism. To further our understanding of the processes that control lithium enrichment, this study focuses on LCT-pegmatites from the Namaqualand Pegmatite Belt (NPB). This was done by integrating the mineral chemistry of mica, zircon, and apatite with quartz oxygen isotopes and whole rock geochemistry. The NPB extends ~450 km in length and 40–50 km in width within the 1.3–1.0 Ga Namaqualand Metamorphic Belt of northwestern South Africa. The studied pegmatites occur in the Richtersveld Magmatic Arc and include Swartkop (Li-rich) and Witkop (Li-poor) pegmatites, hosted by ultramafic and granodioritic rocks.

The findings of this study suggest that the lithium-poor pegmatites are dominated by Li-muscovite, while Li-rich pegmatites contain a broader mica assemblage (Li-muscovite–zinnwaldite–lepidolite) and spodumene. Quartz δ18O values in Li-rich pegmatites range from 9.5 to 10.22‰, whereas Li-poor pegmatites range from 10.22 to 13.00‰. These values suggest Li-poor pegmatites originate from direct igneous sources akin to S-type granites, and support the model that proposes Li-rich pegmatites are magmas that are sourced through anatexis via biotite dehydration and potentially interacted with crustal material.

Zircon geochemistry from Li-poor pegmatite provides further insights. The REE patterns from the Li-poor pegmatite and host rock show low LREE (Light Rare Earth Elements) contents and Th/U < 0.4, consistent with zircons crystallized during magmatic–hydrothermal transition. However, high Hf contents indicate late-stage magmatic evolution. Positive Ce/Ce* values suggest oxidizing crystallization conditions, while negative Eu anomalies imply a magmatic origin, reflecting plagioclase fractionation. The primary phosphates in the Li-poor are fluorapatites, with F contents (~5 wt%) consistent with granitic systems, particularly A-type granites. The REE patterns are enriched in LREE relative to MREE (Middle Rare Earth Elements) and HREE (Heavy Rare Earth Elements), with pronounced negative Eu anomalies indicating crystallization from a felsic melt where Eu2+ partitioned into feldspar. Elevated LREE/HREE ratios and Eu/Eu* > 0.1 suggest relatively primitive compositions and limited fractionation. The absence of monazite or allanite likely accounts for the high LREE retention. Collectively, these data indicate that Li-bearing pegmatites in the NPB were derived from partial melting of metasedimentary rocks, with zircon and apatite chemistry recording signatures of late-magmatic evolution, limited fractionation, and possible magmatic–hydrothermal interaction.

TITLE	**Investigating the Bethal Limb of the Bushveld Complex**
PRESENTING AUTHOR	**Amahle Ngcobo**
UNIVERSITY	University of KwaZulu Natal
EMAIL ADDRESS	221023742@stu.ukzn.ac.za
SUPERVISOR/S NAME/S	Dr W Kruger
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	METALLOGENY AND PALEOGEOGRAPHIC IMPLICATIONS OF LAYERED IGNEOUS COMPLEXES (LICs) AND LARGE IGNEOUS PROVINCES (LIPs)
REGISTERED DEGREE	MSc
ORAL OR POSTER	Poster

The Bushveld Complex in South Africa is the world's largest layered mafic intrusion and a critical source of vanadium (V), chromium (Cr), and platinum group elements (PGEs). While the geology of its exposed limbs has been extensively studied, the concealed Bethal (or Hidden) Limb remains underexplored. In the past, the Bethal Limb was thought to contain only Upper Zone rocks (characterized by the presence of cumulus magnetite). Recent drilling has, however, confirmed the presence of both the Main Zone and Upper zone in the Bethal Limb. This offers a unique opportunity to investigate the petrogenesis of the Upper Zone, which in this region is marked by unusually low initial $^{87}Sr/^{86}Sr$ ratios. While the Upper Zone is thought to originate by magma mixing with resident Main Zone melt in the Western, Eastern and Northern Bushveld, these isotopic signatures suggest the emplacement of a pure endmember that has not undergone any mixing. The presence of Main Zone in the Bethal limb thus raises several important questions. Could the Bethal Limb Main Zone (lacking cumulus magnetite) represent the crystallization products of a more primitive Upper Zone melt (i.e., with an Sr-isotopic signature that matches the Upper Zone?). If the Main Zone matches the Sr-isotopes recorded elsewhere in the Bushveld, then what was the fate of the resident melt to allow for the emplacement of a pure Upper Zone endmember? This project aims to document the Sr isotopic stratigraphy across the Main Zone–Upper Zone transition in the Bethal Limb to determine the nature of melt (or melts) that were emplaced in this region of the Bushveld Complex. The research will integrate core logging, petrography, whole-rock and mineral chemistry, in situ geochemistry, and isotopic analysis to refine current models of Bushveld magmatism. Resolving these competing models may clarify the roles of magma chamber dynamics, magma pathways, and the nature of mantle sources in generating lateral stratigraphic and geochemical variations across the Bushveld Complex.

TITLE	**Petrography and Mineralogy of Copper-Bearing Rocks in the Mutale Copperfield, Soutpansberg Group**
PRESENTING AUTHOR	**Mphanama Thangeni**
UNIVERSITY	University of Venda
EMAIL ADDRESS	Thangenu95@gmail.com
SUPERVISOR/S NAME/S	Dr HR Mundalamo, Emeritus Prof JS Ogola and Prof Dr.Klaus Maas
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	BASE METALS
REGISTERED DEGREE	Doctor of philosophy in mining and environmental geology
ORAL OR POSTER	Poster

The Mutale Copperfield, located within the Soutpansberg Group of South Africa, represents a unique geological entity with historical copper mining activities spanning from 1900 to 1970. Despite its historical importance, limited knowledge exists regarding the genesis, mineralisation processes, and present-day potential of the copperfield. As global demand for copper continues to rise due to its critical role in green energy technologies, reassessing the geological characteristics of deposits such as the Mutale Copperfield is of significant value.

This study integrates field observations, petrographic analyses, and X-ray diffraction to characterise the mineralogical composition of the copperfield. The lithologies identified include quartzite, quartz veins, quartzite breccia, basalt, and amygdaloidal basalt. Quartz is the most abundant mineral, ranging from 26% in quartzite to nearly pure concentrations in quartz veins. Feldspar minerals, including albite and orthoclase, occur in notable proportions, with albite exceeding 70% in some amygdaloidal basalts. Muscovite is locally abundant (up to 16%), while calcite contributes 46–56% in several quartz veins and basalts. Epidote (12–38%) and chamosite (13–17%) represent major alteration phases in the basalts. Copper mineralisation is dominated by secondary carbonates. Malachite, the most abundant copper-bearing mineral, forms 2–4% of the assemblage in altered basalts and quartz veins, whereas azurite contributes up to 2% in basalts. These minerals occur along fractures, veinlets, and amygdales, reflecting supergene enrichment and the structural control on mineralisation.

The mineralogical evidence indicates that the copperfield experienced multiple alteration events. Siliceous alteration is expressed by quartz dominance in quartzites and quartz veins, while hydrothermal alteration is recorded by calcite and epidote enrichment in basalts. Subsequent weathering and oxidation of primary copper sulphides produced malachite and azurite, which now serve as indicators of secondary copper enrichment zones. Overall, the study shows that copper mineralization in the Mutale Copperfield is structurally controlled and closely linked to lithological variation, particularly in altered mafic rocks and quartz-rich veins.

Keywords: Soutpansberg Group; Copper mineralisation; Supergene enrichment; Hydrothermal alteration

TITLE	**Characteristics of Ore Mineralogy Associated with Gold Mineralization in the Windmill orebody, Kalahari Goldridge Deposit, Kraaipan Greenstone Belt, South Africa**
PRESENTING AUTHOR	**Mangapa JR Moloto**
UNIVERSITY	University of Limpopo
EMAIL ADDRESS	mangapa.moloto@gmail.com
SUPERVISOR/S NAME/S	Napoleon Q Hammond, Thabo S Kgarabjang and Anastasia M Nailana
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	GOLD
REGISTERED DEGREE	Master of Science
ORAL OR POSTER	Poster

The Kalahari Goldridge deposit is situated in the Kraaipan greenstone belt in the south-west part of Kaapvaal Craton, about 56 km from Mafikeng in South Africa. The deposit host several ore bodies including the D-zone, A-zone, Watertank and the Windmill, which are hosted in banded iron-formation (BIF). The windmill deposit, which is the smallest of the orebodies is structurally complex, being intruded by numerous east-west trending mafic dykes. Despite being the smallest, it contains high gold grades relatively compared to the other three orebodies.

Petrographic studies reveal that the ore mineralogy associated with gold mineralization include; magnetite, pyrite, chalcopyrite and pyrrhotite. Pyrite is however, the dominant sulphide mineral, which may contain inclusions of chalcopyrite, pyrrhotite and relicts of magnetite. Relicts of magnetite in pyrite and pyrrhotite are consistent typical sulphidation reactions of the replacement of magnetite-rich host rocks by the hydrothermal fluids. Fracture-filling pyrite have no magnetite relicts, suggesting that it crystallized from late-stage, possibly supergene fluids that infiltrated BIF. In the least-altered samples, pyrite grains are isolated ranging from anhedral to euhedral. In contrast, altered samples contain euhedral samples which are intergrown and indicate recrystallization. Gold occurs primarily as inclusions within pyrrhotite and pyrite grains.

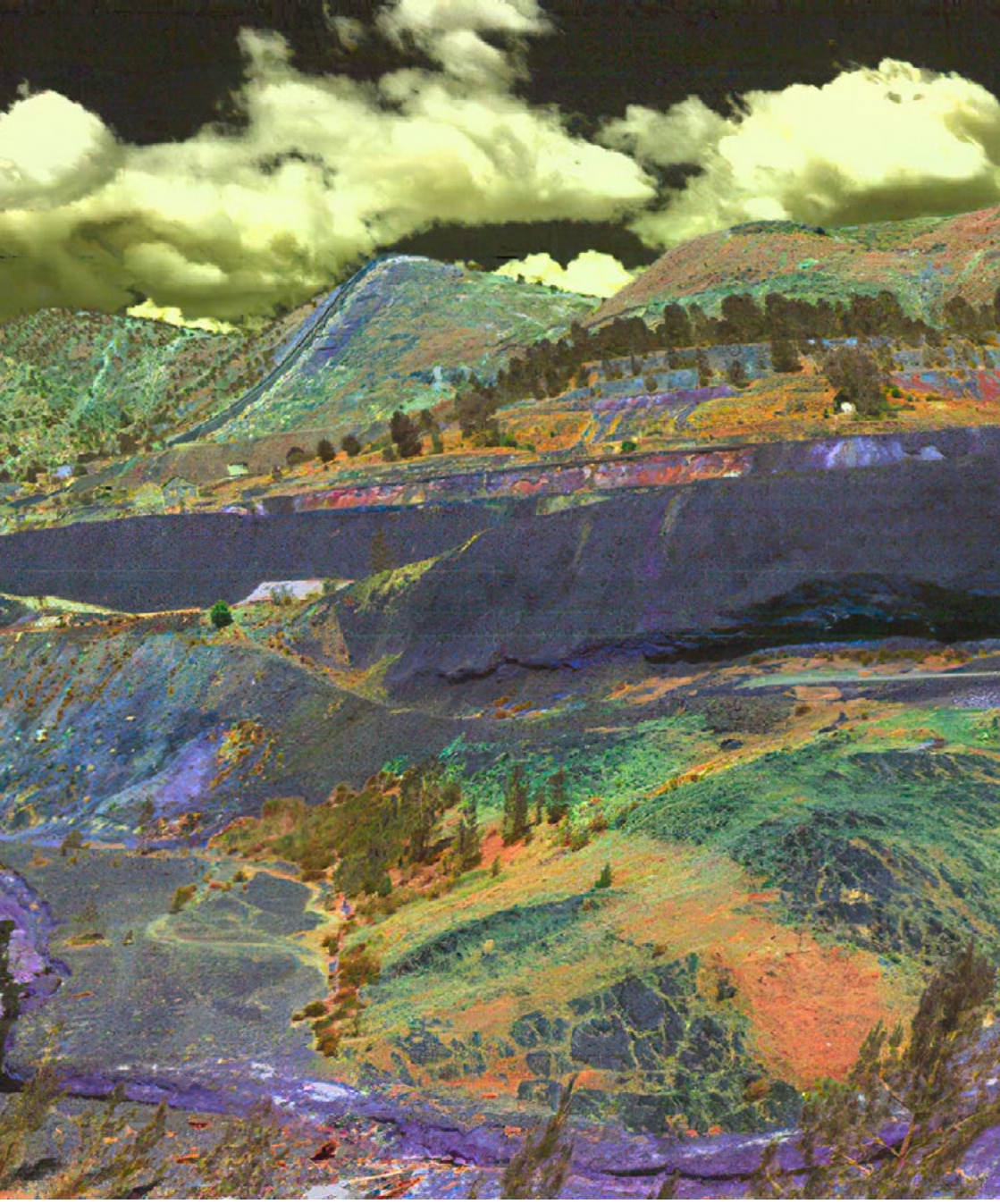
Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP MS) analysis of pyrite and pyrrhotite grain reveals significant concentration of trace elements such as Bi, Ni, Co, Au and Ag in the pyrite grains in Windmill orebody, which reliably reflect the geochemical signature of mineralizing fluids across various deposit types. In particular, silver (Ag) ang gold (Au) exhibits strong positive correlation that indicates that these metals were introduced and precipitated from the same ore-forming fluids under similar physicochemical conditions. This positive correlation also suggest that both Au and Ag exist as nanoinclusions within the pyrite, rather than as a solid solution, and their co-precipitation is linked to the overall fluid chemistry and temperature.

TITLE	**Geological Mapping and Investigation of Natural Hydrogen Gas Potential in the Nkangala district, Mpumalanga province, South Africa**
PRESENTING AUTHOR	**Thabiso Mokobodi**
UNIVERSITY	University of Limpopo
EMAIL ADDRESS	mangapa.moloto@gmail.com
SUPERVISOR/S NAME/S	Prof Napoleon Q Hammond, Thabo S Kgarabjang and Anastasia M Nailana
DSTI-NRF CIMERA FOCUS AREA (VISIT WEBSITE)	ENERGY RESOURCES
REGISTERED DEGREE	Master of Science
ORAL OR POSTER	Poster

Natural hydrogen (H2) is an uncommon but important gas observed in various geological settings. Natural hydrogen is a low-carbon to even zero-carbon energy source, which is a sustainable and environmentally friendly form of renewable energy for isolated communities. This study investigates the occurrence and concentration of H2 to identify and locate its seepages from the surface of the Earth in the Nkangala District of the Mpumalanga Province in South Africa. The geology of the study area is dominated mainly by the sedimentary strata of the Karoo Supergroup, Ecca Group. The study area was selected based on significant concentrations of natural hydrogen gas (H2> 10 ppm) in fairy circles, also known as pans. These pans are shallow, circular to sub-circular depressions that are tens of metres to kilometres deep, where diffusive seeps of H2 can be found. Mpumalanga Lakes District (MLD) is distinguished by a dense group of pans which are located in a relatively humid region with an average annual rainfall of about 800-1000 mm. This region experiences warm and wet summers and cold and dry winters. Hydrogen seeping on the Earth's surface is a potential indicator for the occurrence of H2, as it can guide enriched soils. During exploration of H2, soil gas measurements are taken to determine the concentration of H2 using two gas analysers (Variotech and GA5000). The results of approximately 1000 gas samples from different topographic depressions taken from pans and excavated holes at Hendrina, Grootpan, Chrissiesmeer pans, Daisy's Bistron pan, and G & M Farming Welverdiend pans, show H2 with readings ranging from 0 ppm to 44 000 ppm. Concentration of gas samples greater than 1000 ppm were sampled for analysis. Excavated holes (~2 m) and trenches (~ 1.7 m) in Hendrina showed that hydrogen concentration increases with depth, with the highest reading at the bottom and the lowest reading at the surface. While with trenches, the reading decreased as the sand filled up the holes. There is a significant occurrence of H2 in the study area, the highest values (44 000 ppm) were found on the gravel road next to the Chrissiesmeer pan, with the hardest, wet, and compacted soil.

Keywords: Natural hydrogen, renewable energy, zero-carbon energy, fairy circles.

This study forms part of HyAfrica – Towards a next-generation renewable energy source – a natural hydrogen solution for power supply in Africa. HyAfrica forms part of the Long-Term Joint European Union – African Union Research and Innovation Partnership on Renewable Energy (LEAP-RE). The South African projects are funded by SANDEDI and the DSTI.



DSTI-NRF CIMERA @CimeraSA www.cimera.co.za

Photo Credit: René Booysen, Helmholtz-Zentrum Dresden-Rossendorf e.V. / Booklet Design and Layout: UJ Graphic Design Studio