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Geological Society of South Africa

Council for Geoscience

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SPEAKERS AND ABSTRACTS

Anfisa Skoblenko

Anfisa Skoblenko has been working as a Postdoctoral Research Fellow since November 2024 at the Department of Geology, University of Johannesburg. She holds PhD in regional geology, tectonics and geodynamics (obtained at Geological Institute of the Russian Academy of Sciences in Moscow, Russia).

Interests: Field geology; Subduction processes; High-grade metamorphism; Precambrian continental crust; Microanalysis and geochronology; Ophiolites.

Meso- to Neoarchaean crustal evolution of the southern Kaapvaal Craton: insights from kimberlite-borne granitoid xenoliths

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[2] Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry RAS, Moscow, Russia

[3] University of the Western Cape, Cape Town, South Africa

Rare xenoliths of weakly to strongly deformed granitoid gneisses from the kimberlites of the Bultfontein, Koffiefontein, Roberts Victor, and Star mines, tentatively attributed to the Witwatersrand (eastern) and Kimberley (western) blocks of the Kaapvaal Craton, have been analysed for their bulk geochemical characteristics and U-Pb zircon dates. The results indicate that granitoids from the different localities exhibit comparable stages of formation and evolution during the Meso- to Neoarchaean.

Xenoliths from Star Mine located within the Witwatersrand block of the Kaapvaal Craton include amphibole–biotite (± clinopyroxene) tonalites and leucogranites. These granitoids belong to the calcic to calcic–alkalic series, with K_2O contents of 1.06–3.98 wt.% and ΣREE of 62–477 ppm. They are strongly enriched in LREE relative to HREE ((La/Yb)N = 43–85), consistent with generation and evolution of granitoid melts within the garnet stability field. Zircon cores yield protolith crystallization ages of 3.17–3.06 Ga, with occasional xenocrysts as old as 3.25, 3.28, and 3.42 Ga. Many zircons exhibit convoluted rims with sectoral or oscillatory zoning around the cores. Newly formed zircon domains define age ranges of 3.06–3.02, 3.00–2.82, and 2.72 Ga, interpreted as recording multiple episodes of metamorphism linked to lower crustal anatexis.

The Roberts Victor Mine, located along the Colesberg Lineament marking the inferred boundary between the Kimberley and Witwatersrand blocks, hosts xenoliths of alkali-calcic biotite (± epidote) granites. These rocks are characterised by elevated K_2O contents (2.8–4.8 wt.%) and ΣREE (88–329 ppm), and display highly fractionated REE patterns ((La/Yb)N = 19–25). Zircon cores yield dates of 3081–3050 and 3148–3060 Ma, while occasional overgrowth rims record younger dates of 3060–3029 Ma.

The Koffiefontein and Bultfontein mines, situated within the Kimberley block of the Kaapvaal Craton, host variably graphitized tonalitic and biotite ± amphibole granite xenoliths corresponding to the calcic to calcic–alkalic series. These rocks have K_2O contents of 1.11–4.48 wt.% and a wide range of ΣREE (30–331 ppm), and display moderately to highly fractionated REE patterns (La_n/Yb_n = 14–96). Zircons from the most REE-depleted tonalitic gneiss at Bultfontein yield a mean crystallization age of ca. 2930 Ma, whereas the most REE-enriched granite gives a mean age of ca. 2715 Ma, interpreted as the timing of formation of the parental granitoid melts. Zircons from weakly deformed biotite granites at Koffiefontein show evidence of multistage growth, with core ages of 3.20–3.07 Ga and xenocrysts as old as 3.22, 3.28, 3.32, and 3.38 Ga. Zircon rims define age ranges of 3.00–2.98 Ga and 2.89–2.84 Ma, interpreted as recording episodes of metamorphic overprinting.

All studied granitoid xenoliths are variably deformed and display uniformly magnesian (Fe# = 0.31–0.59) and metaluminous (A/CNK < 1) characteristics, consistent with TTG and I-type affinities. The geochronological data indicate voluminous magmatism at ca. 3.1 Ga and widespread lower-crustal high-grade metamorphism at 3.06–2.72 Ga in both the Kimberley and Witwatersrand blocks, suggesting their possible coeval crustal evolution as part of a single crustal segment during the Meso- to Neoarchaean.

JAC (Braam) Jankowitz

Braam holds an MSc (Geology/Geochemistry, 1986) from UOFS, is a professional geologist with diverse experience in various levels of project management, mineral resource management and mining; both exploration, open pit and underground operations. Worked for major corporations and junior companies in exploration and mining in various African countries, Australia and Arabian Peninsula. Been involved with numerous precious metal (Au, PGE & IOCG), diamond as well as various industrial mineral (minerals sands & REE) exploration and mining projects. Open pit experience on vein hosted REE and gold deposits, mineral sands, alluvial diamonds, platinum and uranium deposits. Underground mining experience on shear zone and vein hosted gold deposits.

Wide managerial experience in Africa, Arabian Peninsula and Australia that covers most aspects of exploration, data acquisition, resource determination as well as mining and processing (both open cast & underground; both CIL/CIP and BIOX) of vein hosted gold deposits, mineral sand deposits, tabular precious metal (PGE) deposits, poly-metallic base metal deposits (Cu & Zn floatation circuits; gravity & jigging), REE deposits (narrow veins - jigging), alluvial diamond and kimberlite deposits (rotary pan and DMS) as well as IOCG deposits.

Extensive operational and financial management with associated computer skills in green- and brown field to advanced stage exploration projects as well as open cast and underground mining projects. Wide experience in dealing with various governmental institutions with regards to tenement management as well as social upliftment programs in various African countries. Proven experience in managing and supervising of mining and processing contractors as well training and motivating junior staff members and actively promoting safety awareness to all staff members, colleagues and contractors.

Currently employed by the Torque Africa Group with specific focus on business development in Namibia.

A snapshot on the production history (Mar 2014 to Mar 2018) of the Blue Gum Deposit, Ventersdorp District, Northwest Province

JAC (Braam) Jankowitz, Torque Africa Group

The Blue Gum Diamond Mine (previously called the Tirisano Mine) is located some 35km north of Ventersdorp and approximately 150km west of Johannesburg. The Blue Gum alluvial diamond deposit straddles three farms i.e. Nooitgedacht 131IP, Hartbeestlaagte 146IPen Zwartrand 145IP.

These properties (totalling 10,805.57ha) are well located within the alluvial diamond fields of the North-West Province. Intermittent prospecting and bulk-sampling activities have been taking place on these farms since 1979. Etruscan Resources obtained the properties from Mountain Ash (Pty) Ltd in 2002 and released an initial NI 43-101 compliant technical report by RSG Global in August 2003. The estimated in situ indicated diamond resources on the Nooitgedacht property have been estimated at 12.3 million m³ at an average grade of 2.8 carats per 100m³.

Etruscan Resources conducted opencast mining of the Tirisano project from 2002 – 2008. Independent “Technical Reports” and follow up Resource Statements were released by Etruscan (Marshall, 2006, Marshall, 2007; Marshall, 2008; Marshall, 2009; Marshall, 2010). Rockwell acquired the property in October 2011 and started trial mining. Subsequent resource estimations were conducted (Marshall & Norton, 2012; Marshal & Norton, 2014).

The current owners acquired the Blue Gum Diamond Mine from Rockwell Diamonds Inc in 2014, and opencast mining has been conducted along various operations within the boundaries of all three farms i.e. Nooitgedacht 131IP, Hartbeestlaagte 146IPen Zwartrand 145IP.

An infill RC drilling program of 5,000m was conducted between November 2017 and February 2018. This campaign was focused along the northern extensions on

Nooitgedacht and central portions on Hartbeestlaagte of the Blue Gum deposit respectively. A further 470m was drilled at Zwartrand.

Due to the extent of the operations across the three properties, together with limited survey data of the existing and historical mining areas, more advanced drone survey techniques have been applied. Quarterly drone surveys of the entire mining area have been done which formed the basis of the DTM used to calculate the depleted volumes for the period Mar 2014 to Mar 2018. This technique also caters for more accurate monthly reconciliation with production volumes and tonnages derived from load and bucket counts.

The volumes of mined at the Blue Gum Mine have increased from approximately 885,000m³ in 2014-15 financial year to 1,007,000m³ in 2015-16, increasing to more than 1,158,000m³ in 2016-17 and to over 1,420,000m³ in the 2017-18 financial year. The total volume mined for the period Mar 2014 to Mar 201 amounts to approximately 4,500,000m³. Over 81 200 carats were recovered with an average grade of 1,82cphm³. The average stone size of 0.85 carat was recorded during this 4-year period of continuous open cast mining production.

An updated in-house resource estimation has been published, incorporating the new volumes from the 2018 drilling campaign as well as the volumes mined and grade recovered during 2014 to 2018.

Daria Semikolennykh

Dr Daria Semikolennykh is a postdoctoral research fellow at the Geoluminescence Laboratory at the University of the Witwatersrand (South Africa). Her research focuses on Quaternary geochronology, geoarchaeology, geomorphology, and palaeogeography, with a particular specialisation in luminescence dating methods, including OSL, IRSL, and rock-surface luminescence.

Luminescence dating of Quaternary sedimentary deposits in mining landscapes: approaches, potential, and limitations

Daria Semikolennykh[1], Alastair C. Cunningham[1], Mary Evans[1], Axel Hofmann[2]

[1]School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand,

Quaternary sedimentary deposits preserve evidence of sediment accumulation, erosion, and reworking associated with past environmental changes. In mining landscapes, such records are particularly valuable because they can help reconstruct the formation, redistribution, and preservation of economically important mineral concentrations. Establishing the timing of these processes provides a basis for relating mineral concentrations to specific stages of landscape evolution. Luminescence dating directly constrains the burial of quartz- and feldspar-bearing sediments by dating their last exposure to daylight, making it applicable to many Quaternary deposits that lack reliable chronological markers (Murray et al., 2021).
Here, we discuss quartz OSL, feldspar IRSL/pIRIR, and rock-surface luminescence dating as complementary approaches for dating mining-relevant Quaternary deposits. Quartz OSL is most effective for Late Quaternary sandy deposits, typically from recent decades to ~100–150 ka, with greater ranges possible in low-dose-rate settings. Feldspar IRSL/pIRIR can extend dating into the Middle Pleistocene. Rock-surface luminescence dating targets cobbles and boulders, allowing exposure and burial histories to be assessed where sand is absent or poorly bleached (Sohbati et al., 2011, 2012; Gliganic et al., 2024).
Relevant examples include rock-surface luminescence dating of Pleistocene fluvial terraces and gravel bars, where conventional sand-based luminescence dating may be limited. South African applications are illustrated by preliminary results from the Vaal River diamond fields near Barkly West and Windsorton, based on pilot luminescence sampling of selected fluvial terrace deposits, and by a Richards Bay coastal dune example, where OSL/pIRIR ages, grain-size, and heavy-mineral data link Late Quaternary dune development with sediment recycling, stabilisation, and heavy-mineral enrichment. Together, these examples show how

luminescence methods can build process-based chronologies for mining-relevant Quaternary sediment bodies.

Dr Debbie Claassen

Dr. Debbie Claassen (PhD, Pr.Sci.Nat., FGSSA) is a Chief Scientist at the Council for Geoscience with 19 years' experience in research-driven and applied geoscientific studies. Her fields of expertise include geological mapping, Quaternary science, neotectonics, sedimentology, and land degradation studies. She has led various multi- disciplinary mapping programs across the Eastern Cape, detailing lithostratigraphy, structural geology, geohydrology, and mineral potential within the Cape Fold Belt, Karoo Basin and Cenozoic environs. She contributed to and led multiple neotectonic and site safety investigations supporting seismic hazard analyses for existing and proposed nuclear power plants in South Africa. But her latest focus has been on the formation and evolution of erosional gullies and the colluvial sediments in which they develop in the northeastern hinterland of the Eastern Cape.

Geological Mapping of Alluvial Diamond Systems in the Northern Cape and North West Provinces, South Africa.

D. Claassen

Council for Geoscience, Gqeberha Regional Office, South Africa,

The South African mining sector is undergoing a long-term decline in alluvial diamond mining. To prompt renewed efforts in the identification and development of underexploited areas, the Council for Geoscience (CGS) prioritised detailed 1:50,000-scale multi-disciplinary geological mapping in areas across the Northern Cape and North West provinces. Mapping efforts included the integration of high-resolution geophysical data, remote sensing, and extensive field-based geological mapping to delineate the occurrence, distribution, and controls on the deposition of alluvial diamond-bearing gravels.

Mapping focused on four well-known diamondiferous gravel fields between Bakerville and Christiana along the middle Vaal River in the North West. These investigations highlighted the strong structural and geomorphological controls on gravel deposition, including runs, sinkholes, dolines, and palaeo-terraces. The spatial distribution and preservation of these deposits are closely linked to karst development within dolomitic bedrock, erosion patterns and fluvial reworking since the Cretaceous, all of which are associated with regional uplift and African surface evolution. Mapping further suggests that the Dwyka Group played a significant role in the supply and redistribution of diamonds, with possible initial transport linked to glacial processes and subsequent concentration along features analogous to eskers and drumlins or as a thin sheet of moraine on the Chuniepoort Group dolomite.

In the Northern Cape, mapping focused on alluvial gravels associated with the lower Vaal and middle Orange River systems. These deposits occur along both active and palaeo-channels, as well as a series of stepped terraces ranging from 0 to 125 m above present river levels. Systematic mapping revealed a clear relationship between terrace elevation, age and preservation potential, with younger, lower terraces exhibiting better preservation. Fieldwork identified and mapped out the lower Riverton Formation terrace deposits, while mapping of the undulating, irregular and weathered bedrock surfaces, demonstrated how lithological and structural controls played a critical role in the trapping and preservation of diamondiferous gravels. Additionally features such as potholes, scours, joints, and faults were also identified as important trap sites, that can locally enhance diamond concentration. The mapping programme re-evaluated the traditional exploration models, particularly the focus on near-surface Rooikoppie gravels associated with calcrete and dissolution features ('makondos'). Through integrated mapping and subsurface interpretation, the CGS identified previously overlooked deeper basal gravels within buried palaeochannels beneath calcrete, which demonstrates the future economic potential for the region.

Edgar Stettler

Dr Edgar Stettler holds MSc and PhD degrees (Geophysics) from Pretoria University, was a part time lecturer since 1980 and Extraordinary Professor of Geophysics at that University between 2000 and 2009. He has been lecturing on Electromagnetics at the University of the Witwatersrand since 2007, where he holds the position of Honorary Professor in Geophysics. E. Stettler is a past president (1994) and Meritorious Geophysical Service Award holder of the SA Geophysical Association (2009), a recipient of the prestigious Dr. Rudolf Krahmann Gold Medal award (2013) and an active member of the International Society of Exploration Geophysicists, Tulsa, USA since 1976. He represented the SA earth science community on SACNASP (1994-2004) and represented SA at the Geophysics and Seismology Working Group at the SADC Mining Co-ordination Unit. He is also a Fellow of the Geological Society of SA. Edgar joined the Geological Survey Geophysics Unit in 1975 as a student and was the Divisional Manager for Geophysics, Seismology and Geohydrology between 1994 and 2004. He then joined the Thani Group in Dubai (2005-2010) as a geophysical consultant in gold, base metal and oil exploration. Between 2010 and 2018 he was a director of the Hamburg Alternative listed Swiss company, Afrika Gold AG with assets in Ghana and South Africa. He has an extensive refereed publication list dealing mostly with tectonics as revealed by geophysical data. GEONICS of Canada referenced his theoretical work on borehole electromagnetics in a patent. With Prof's F. Kamenetsky (University of

Muenchen) and G. Trigubovich (Novosibirsk State Technical University) he co-authored the textbook 'Transient Geo-electromagnetics', published in 2010. Edgar specializes in base metal, diamond and groundwater exploration with geophysical techniques and his current interest's cover drone based geophysical surveying where he is involved in magnetic, TEM, MMR and NIR surveying.

On the origin of the Lichtenburg diamonds.

Have we solved the mystery?

E H Stettler [1, 2]

[1] School of Geosciences, Witwatersrand University; 2 AeroPhysX Intl, Abbotsford, Canada.

Since the discovery of the alluvial diamonds on Elands Putte in 1926 the origin of the diamonds has been speculated on. Draper hypothesized that the diamonds originated from dolomitic chert and a conglomerate bed at the base of the Pretoria shales. Alex du Toit (1951) and D Harger favoured a kimberlitic source while De Wit (1980) suspected the Dwyka tillite as being an important contributor to a source. Stettler (1979) favoured the origin of the diamonds being from a local kimberlitic source as garnets from Pienaar's Pothole had a kimberlitic origin. An important argument for the tillite source was the recognition by De Wit (2016) of the gravel runs not being riverine but preserved Permo-Carboniferous paleo-eskers, left over from the deglaciation of the Dwyka ice sheet.

Complicating matters, a weathered kimberlite dyke was found at Van Wyk's Pothole on Grasfontein by the Synoidines brothers, at 'Mike se gat'. De Bruin (2003) at CGS analysed collected garnet and ilmenite samples and concluded that they are of the Lesotho type.

HP Van Heerden started exploring the river gravels of the Hartz river on the farm Klipbankfontein (Manana) in 2014 and extracted large diamonds, amongst them a 37ct green-yellow flawless diamond with no abrasion marks. Also with the diamonds, purple red garnets, ilmenite and olivine were recovered.

High resolution aeromagnetic data collected by CGS in about 2002 indicated vague magnetic anomalies next to a prominent diabase dyke on Manana at the Van Heerden diggings and identified patches on Google Earth Pro that he believed were underlain by kimberlite pipes. Stettler, De Wit, and Jaco Smit made several trips to

Manana to further the search for the elusive kimberlite pipes. Dan and Roy Novick from the Gold Company, Australia sponsored three core drill holes to 120m. Magnetics, gravity, audio-frequency magnetotellurics (AMT) and LOZA ground penetrating radar (GPR) followed and compelling anomalies that could be interpreted as a less dense kimberlite tuff-filled caldera in a dense dolomitic host rock was identified. Drill core contained sediments amongst which thin layers of immature coal and even a dragonfly like insect that immediately decomposed were found but proved the sediments to be post Ecca and that the geophysically derived area formed part of a local lake as also concluded by Coen Visser, a geologist from Kimberley.

From drill and reverse circulation cores on Manana Van Heerden separated the heavy minerals with bromoform, treating them with hydrofluoric acid and extracted kimberlitic garnets, ilmenite and one or two micro diamonds. Mike Lynn, on the basis of the rounded xenoclasts identified the borehole cores as typical Dwyka, but a petrologist at CGS identified the core matrix as volcanic ash. De Wit independently had samples from the Van Heerden digging spoils analysed and more than 40 kimberlitic garnets and 2 green grains being either olivine or eclogite were identified. All this came to an end with an attack on HP Van Heerden on the entrance of a major bank in Klerksdorp in 2019 whereafter he passed away in hospital after an operation to restore his broken pelvic bone. A true friend and source of great knowledge on the Lichtenburg diamond fields was lost and is severely missed. He also had an extensive collection of polished, fancy coloured diamonds mostly from the Lichtenburg diamond fields which supports again the kimberlite origin.

The mystery is still unresolved and most probably both the Dwyka Tillite (eskers) and kimberlites contributed to the diamond source. But I also believe that somewhere near Manana a kimberlite is still to be found and the search continues.

Geophysical techniques applicable to the search for palaeo gravels and kimberlite in the Lichtenburg vicinity.

E H Stettler [1, 2]

[1] School of Geosciences, Witwatersrand University; [2] AeroPhysX Intl, Abbotsford, Canada.

The application of geophysical techniques to geology, is similar to radiology in the medical profession. Sensors that can measure very small aberrations in the earth's magnetic, electromagnetic and gravity fields or records sunlight reflected photons are part of the passive geophysical techniques. Electromagnetic, dc electrical, seismic and ground penetrating radar (GPR) are active techniques where the user has to expend energy to send a signal into the earth and record the deviation from the original energy to obtain eventually an image of what caused the deviation.
Gravity surveying uses local changes in gravitational attraction and rocks with a lower density have a slightly smaller attraction than denser rocks. In this regard gravel bodies hidden in a host rock of dolomite or Ventersdorp lava can be mapped because of the low density (2g/cc or 2000kg/m^3) of the gravel and examples are published in the learned literature covering gravel in dolomite and Ventersdorp lava near Lichtenburg and Mafeking.
Gravel bodies also have an electrical contrast with respect to a host rock of dolomite or Ventersdorp lava. Because the gravel occurs with a finer matrix that is conductive, electrical and electromagnetic techniques can be used to prospect for and image them. Apart from the Geonics EM34-3 frequency domain apparatus or dc resistivity profiling (ERT), time domain electromagnetics (TDEM) can be flown by helicopter (SKYTEM) and now also by drone. Drone measurements (DroneTEM) are now possible in SA with unique equipment built for AeroPhysX.
Depending on the gravel composition and its magnetic properties magnetic measurements can also be applied where the gravel contains a good percentage of

BIF cobbles and pebbles as at the Mahura Mutla, Warrenton and Taung occurrences. Palaeo rivers also exploited dykes and faults and magnetic measurements are used to follow dykes and faults along which gravels were sometimes deposited. So-called young 'potato' gravels are to be found on the Zamenkomst - Reybult boundary along a N-S dyke as a Lichtenburg example.

A GPR using a wide frequency spectrum source caused by firing spark plugs as used by the Ukrainian company Loza was undertaken on Ruigtelaagte and Manana as well as making use of naturally occurring Telluric measurements using the Chinese TYM30 apparatus popular under water diviners. Reasonable results but not easily interpretable and sometimes very ambiguous were experienced. The latter instrument can indicate vertical contacts quite well.

For detecting kimberlites, a combination of TDEM, magnetics and gravity surveying is normally undertaken but experienced prospectors also use the TYM30. A kimberlite or lamproite consists overwhelmingly of olivine but is only magnetic if the minerals magnetite or ilmenite are present. The unweathered kimberlite/lamproite rock is dense. In both rock types, olivine weathers fast and forms serpentinite that is electrically conductive and less dense than kimberlite or the host rock. Thus airborne TEM, magnetics and gravity gradient are a popular combination but airborne gravity by drone is still a realistic dream, and great efforts are made to achieve a miniature gravity sensor based on a MEMS chip.

Geophysical methods remain a vital tool to prospect for new diamond fields especially under surface cover rocks.

Emmanuel Chirenje

Emmanuel Chirenje is a Geophysicist at the Council for Geoscience (CGS). He holds an MSc in Geophysics and Exploration Geology and a Postgrad Diploma in Project Management with more than 18 years field experience. He started his career in greenfields and brownfields exploration with then Kinross Gold Corporation (Exploration Division) in Zimbabwe targeting gold and base metal commodities. He then worked in consultancy before joining the CGS in 2008 where he has worked in various projects. His responsibilities include managing large and small scale airborne and ground geophysical surveys, data processing and interpretation for various applications.

Ground Geophysics Techniques for Alluvial Diamonds Exploration in the Northwest and Northern Cape Provinces of South Africa

E. Chirenje[1], S. Sebothoma[1], M. Sethobya[1], D. Ngobeni[1], Z. Nxantsiya[1]
Council for Geoscience, Pretoria

Ground geophysical surveys were carried in the Northwest and Northern Cape Province, South Africa to assess effectiveness of geophysical techniques for alluvial diamond exploration and as part of training for Council for Geoscience staff. The techniques that were assessed for alluvial diamond exploration include magnetics, radiometrics, gravity, seismic refraction tomography (SRT), electrical resistivity tomography (ERT) and electromagnetics (EM). In the Windsorton area, magnetics was a useful tool for mapping the Ventersdorp andesitic bedrock. Disturbances in the Ventersdorp lava bedrock made it possible to use gravity to infer potential paleochannels. Radiometrics appeared to be effective in areas where the Rooikoppie gravels are exposed. Radiometrics was not effective in areas of thick calcrete. FDEM proved to be a quick, potential channel mapping tool in some areas. ERT mapped bedrock depressions possibly hosting the Rietputs gravels with the challenge of not distinguishing between gravels or materials filling the mapped depressions. The gravels in the Schweizer-Reneke study area overlie Swazian biotite gneiss, pegmatite and granites to the west and they overlie Rietgat andesitic lavas, conglomerates and shales to the east. Magnetics indicated subtle high magnetic anomalies that are probably due to high concentration of iron oxides (magnetite and ilmenites) that are often associated with alluvial diamonds on the farm. Magnetics therefore formed a quick and economic way of delineating areas that may have potential for gravel. A gravity low zone on the western portion of the study area was mapped possibly tracing an alluvial channel. A TDEM profile carried out on fresh ground that has not been mined indicated a depression that coincided with the low gravity and subtle magnetic high anomalies possibly indicative of the old drainage system that facilitated deposition of the alluvial gravels. ERT and SRT showed comparable results but with the challenge that the ERT could not distinguish between the topsoil and the gravel but is very useful for bedrock topography mapping which aids in mining planning. Magnetics, gravity and TDEM picked near north-south oriented interpreted fault structures that are known for high yield water boreholes providing supplementary information for mining planning. Considering the shallow depth of the gravels, it appears the use of gravity, ERT and SRT are not economic for exploration purposes at that particular site. Radiometric results proved difficult to use because of the excavations that are scattered on the farms. At Longlands only ERT and SRT were deployed. The results from both methods showed variations in the Dwyka tillite or Ventersdorp lava bedrock topography. For alluvial exploration the occurrence of depressions in the tillite or lava bedrock is usually an indication of potential paleochannels adjacent to the present-day Vaal River. Channel thickness at Longlands were on average 20m but thickness and depths greater than 20 m were also noted. Deployed geophysical methods were successful, albeit with limitations inherent to each specific method and prevailing site-specific geological environment. Due to ambiguity and non-uniqueness of geophysical interpretation, trenching and drilling of targets is always recommended to ascertain and complement any findings from geophysical methods.

Hielke Jelsma

Hielke Jelsma is Director and Co-Founder of geSIGMA (Pty) Ltd and Honorary Research Fellow at Stellenbosch University. He holds a PhD in geology from Free University of Amsterdam (1993) and has over three decades of experience spanning academia, consulting, and industry. He has held senior roles at De Beers and Anglo American, where he led initiatives in exploration innovation, mineral systems science, and global project generation. His expertise covers a wide range of commodities and deposit types including magmatic Ni-Cu-PGE, diamonds, REE, lithium, VHMS, and porphyry and sediment-hosted copper. A specialist in field mapping, structural geology, tectonics, and economic geology, Hielke has published over 65 peer-reviewed papers. Ongoing interests include mineral systems science, metallogenesis, lithosphere geodynamics, supercontinent cyclicity, and regional geological assessments. He is registered as a Professional Natural Scientist; he is an elected Fellow of the Geological Society of South Africa and Honorary Life Member of the Geological Society of Zimbabwe.

Structural Controls on the Geology of the Lichtenburg–Bakerville Diamond Fields, North West Province, South Africa

Hielke Jelsma[1,3] and Sojen Joy[2,3]

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The Lichtenburg–Bakerville alluvial diamond fields of the North West Province have produced in excess of ~12–15 million carats since their discovery in 1926 (Marshall, 1987; de Wit, 1996; Wilson et al., 2006), making them one of South Africa's most significant secondary diamond deposits. The deposits occur as narrow, sinuous gravel "runs" and gravel-filled sinkholes ("potholes") developed on a broad, low-gradient erosion surface cut into Malmani Subgroup dolomites at ~1,500 m elevation. This surface represents a polyphase unconformity characterised by prolonged exposure, karstification, and episodic burial and exhumation, with preserved evidence of pre-Pretoria karst, Karoo sediment remnants, and Dwyka glacial erosion (de Wit, 2016).

Karst processes exert a primary control on diamond concentration and preservation. Dissolution of dolomite along faults, joints, dykes, and lithological contacts is well established (Stettler, 1979; Wilkins et al., 1987), generating solution cavities that evolved into sinkholes, fissures, and channels which subsequently trapped diamond-bearing gravels; gravel-filled sinkholes are commonly of high grade, reflecting efficient trapping within these karst depressions. Structural geology also exerts a first-order influence on deposit geometry: post-Transvaal tension fractures and faults trending northeast and north-northwest define zones of enhanced karstification and are associated with linear arrangements of sinkholes and gravel runs detectable as gravity lows, while at Bakerville the intersection of multiple dolerite dykes produces complex zones of isolated sinkholes and subsidiary runs, highlighting the importance of structural intersections in localising mineralisation (Stettler, 1979).

Run morphology and origin remain debated. Stettler (1979) attributed the narrow (20–500 m), up to 30 km-long runs to palaeoriver courses governed by sinkhole exploitation and episodic collapse. De Wit (2016) instead proposed the runs as proximal palaeo-eskers formed during final deglaciation of the Dwyka ice sheet, citing uphill gradients, percussion-scarred boulders, and absence of Cainozoic fossils despite ~90 years of mining. Critically, Ar-Ar dating of clinopyroxene inclusions in two diamonds from Van Wyks fissure fill yielded emplacement ages of 500–600 Ma, while low-U, likely mantle-derived zircons from Pienaars pothole gave U-Pb ages of 489–664 Ma (De Wit et al., 1998; de Wit, 2016), implying a proximal, late Neoproterozoic–Cambrian kimberlite source, similar in age to some important diamond-bearing kimberlites elsewhere in southern Africa (Jelsma et al., 2004, 2009). These models are not mutually exclusive, as both emphasise strong structural and karst controls on sediment accumulation. The preservation of the deposits is attributed to long-term stability and limited erosion of the dolomite surface since Karoo times, allowing reworking and concentration within karst systems.

In summary, the Lichtenburg–Bakerville deposits are controlled by the interaction of (1) a long-lived karstified dolomite surface, (2) a structurally controlled fracture and dyke network that governs karst development and sediment pathways, and (3) reworked diamondiferous material derived from older primary sources. This integrated framework highlights the importance of structural–karst coupling in controlling both the localisation and grade of these unique alluvial diamond deposits and provides a basis for targeted exploration focusing on structurally favourable karst domains.

Ingrid Chinn

Ingrid Chinn completed a PhD on diamonds from the George Creek kimberlite (Colorado, USA) at UCT under the supervision of Prof John Gurney. She then joined De Beers Exploration in 1998, gaining exposure to diamonds from mines and diverse deposits from countries including South Africa, Botswana, Zimbabwe, Angola, Canada, Brazil and India. In 2025 she moved to Mineral Resource Management but retains a keen interest in diamond exploration.

Lichtenburg diamonds – comparison with other secondary deposits and potential sources

Ingrid Chinn
De Beers Group Services

A century after the discovery of diamonds in Lichtenburg, many questions remain as to the nature of primary sources that contributed to this significant alluvial field from which ~8 million carats have been recovered. The mystique of Lichtenburg diamonds is enhanced by the history of the exceptional 5.05 ct red Kazanjian diamond, found in the 1920's heyday of diamond mining in Lichtenburg. This diamond was seized by the Nazis in World War II, hidden in a salt mine and not initially recognised as a diamond when subsequently recovered. Unusual colours appear to be a feature of some Lichtenburg diamonds and may be useful to exclude or confirm potential primary sources.

The inclusions visually identified in a parcel of diamonds from Grasfontein indicate the presence of both the eclogitic and peridotitic paragenesis. Eclogitic diamonds may be of greater abundance, based on the presence of unusual CO_2-bearing diamonds and yellowish diamonds with residual unaggregated nitrogen defects. This contrasts with diamonds of equivalent small sizes from the Kimberley, Finsch, Venetia and Cullinan mines, where peridotitic diamonds are dominant.

Derek Robinson, former diamond specialist at De Beers, pioneered the use of diamond morphology and surface features as a framework to understand the sequence of events that affected diamonds. Surface feature data can provide valuable information about diamond growth and mantle residence conditions, the effect of resorption in mantle host rocks and during kimberlite transport and emplacement, and features (abrasion, impact scars) acquired during sedimentary transport and concentration processes.

Despite considerable effort using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS), Laser-Induced Breakdown Spectroscopy (LIBS) and Fourier Transform Infrared (FTIR) spectroscopy, these analytical techniques are unable to determine the geographical provenance of diamonds (Smith et al., 2022). Diamond surface features are thus more useful to compare populations/parcels of diamonds from alluvial deposits with diamonds from potential primary sources. Kimberlites and lamproites sample multiple diamond populations of different ages and paragenesis from various diamond bearing substrates, hence relating alluvial diamonds likely sourced from multiple kimberlites to potential primary sources results in significant challenges. Furthermore, diamonds from upper volcaniclastic kimberlite in a single body will have a different prevalence of resorption characteristics compared to diamonds recovered from deeper coherent/hypabyssal kimberlite and hence the erosional history must be well constrained. For example, in the same magma pulse, diamonds from volcaniclastic kimberlite will dominantly exhibit smooth rounded tetrahexahedral faces whereas diamonds from hypabyssal kimberlite are more likely to show corrosion sculpture and shallow depressions. Surface feature data are presented for diamonds from Lichtenburg, allowing for comparison with other alluvial localities in South Africa (Schweizer Reneke, Wolmaransstad, Ventersdorp, Taung and Mafikeng) and potential proximal primary sources such as Helam (Swartruggens) and Palmietfontein, and more distal primary sources such as the Cullinan (Premier) Mine and Dullstroom kimberlites.

Ishta Maharaj

Ms. Ishta Maharaj is a 23-year-old Masters student at the University of KwaZulu-Natal, where she is currently pursuing a Master of Science (MSc) in Geological Sciences. Her research, titled “Detailed bedrock morphology and structural geology controls on diamond traps offshore Hottentot’s Bay, southern Namibia”, utilizes machine learning techniques to rigorously test the relationship between the structural framework and gravel distributions offshore Namibia for mineral exploration purposes. She currently holds a Bachelor of Science and Bachelor of Science (Honours) in Geological Sciences, both in which she achieved *summa cum laude.* In 2025, she was the recipient of the “Top 4th year student” award by the GSSA, which recognises the top honours student in Geological Sciences across universities in South Africa, and the “Luhlaza Consulting Award” for graduating as the top student in Geological Sciences at the University of KwaZulu-Natal. Her research interests include structural geology and exploration.

Detailed bedrock morphology and structural geology controls on diamond traps offshore Hottentot's Bay, southern Namibia

Maharaj I., Hoyer L., Green AN.

Geological Sciences, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal

The world's largest diamond placer deposit occurs along the coast of Namibia, 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. Deformation produced a structurally complex morphological pattern that controls the distribution and accommodation of overlying gravel beds that are endowed with alluvial diamonds. The strong correspondence between gravel and diamonds along the continental shelf indicates the presence of gravel as a proxy for diamondiferous zones. However, the precise relationship between the underlying bedrock structures and diamond concentration is poorly understood, and this project aims to rigorously test this relationship using machine learning techniques.

Lineament analyses of ultra-high resolution geophysical data involved manual digitisation of bedrock lineaments, including fractures, faults and foliation planes as well as their relative displacements and rotations 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. Primary lineaments represent S1 foliation that display a N–S to NNW–SSE trend and are segmented, displaced and rotated by secondary lineaments. Three sets of secondary lineaments occur, trending ENE–WSW, ESE–WNW and SSE–NNW. The development of fault duplexes and splays resulted in significant lateral drag and curving of primary lineaments to produce valuable kinematic indicators. A tectonic contact was inferred by differences in lineament orientation and deformation intensity in the westernmost portion of the study area. The contact represents the main thrust zone, with strike-slip faults, Riedel patterns and ridges indicative of sinistral transpression within the Gariep Belt, with a horizontal regional maximum principal stress axis oriented ~E–W. These structures are likely associated with the D2 transpressional event that occurred in the Marmora Terrane during oblique collision between the Kalahari and Rio de la Plata cratons, whereas dextral faulting, shearing and en-echelon tension fractures are related to D3 and post-D3 transtension. A dextral shear zone and clockwise rotation in proximity to the inferred contact represents localised strain accommodation during fault reactivation.

A detailed prospectivity pattern will be modelled by coupling structural data and gravel distributions, obtained from >8000 boreholes at a 50 m x 50 m grid, using Python software. This will target structural trap zones with the highest diamond concentration, a first for southern African offshore placer resource estimation.

Jazmynn Eksteen

Ms. Jazmynn Eksteen is a second-year Master of Science (MSc) student in Geological Sciences at the University of KwaZulu-Natal. She holds a Bachelor of Science (BSc) in Geological Sciences and a Bachelor of Science (Honours) in Geological Sciences, graduating with cum laude distinction. Her research interests lie within the field of geological sciences, and her current master's research "The Changing Fortunes of a Mudbelt: Why Seafloor Mapping Matters" focuses on the sediment distribution offshore the Western Cape.

The Changing Fortunes of a Mudbelt: Why Seafloor Mapping Matters

Eksteen, J.D[a] and Green, A.N[a,b,c]

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[b] School of Geography and Environmental Science, Ulster University

[c] South African Institute for Aquatic Biodiversity

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.

James Murry Davidson

James Murry Davidson began his geological career with De Beers in 1964 as a field assistant, contributing, amongst other things, to the original bulk sampling programme at the Finsch mine. He qualified in 1969 and completed his Honours degree at Rhodes University in 1971. His career spans base and precious metals, uranium, alluvial diamonds, kimberlite research, and mine development across South Africa, Namibia, Brazil, Canada, and the USA.

Going independent in 1990, he played a pivotal role in resurrecting the Helam, Star, and Bobbejaan mines, listed on the ASX, before merging with Petra Diamonds as Technical Director, where he led the acquisition and resurrection of former De Beers mines and was party to lifting Petra's production to in excess of **4 million carats annually**. He retired from Petra in 2018 as a fellow of the geological Society of South Africa, and received the Des Pretorius Award for contributions to economic geology and exploration in 2019.

Still healthy and active.

Is This the Next Lichtenburg? - The case for alluvial diamond trap sites at the base of Die Kaapse Berg

James Murry (Jim) Davidson

Independent Geologist | Technical Director (ret.), Petra Diamonds

The Bellsbank and Bobbejaan kimberlite groups, two en-échelon fissure occurrences with approximately 3 km of individual strike length each, separated by some 2.5 km, produced diamonds of exceptional quality that were sought after by diamantaires worldwide throughout their production lives from 1952 to 2018. These Group 2 kimberlites, are dated at approximately 120 million years and have suffered severe erosion: only root zones are preserved, the upper portions having been long removed. It is estimated that in excess of 7 million carats of diamonds have been mobilized over the escarpment in the Cretaceous (to the headwater erosion point of the current watershed).

This presentation advances the contention that the Harts River occupies a downthrown graben valley, formed by continued crustal uplift followed by potential keystone rift collapse. This structural interpretation is supported by the differential depth to the Ventersdorp Formation: some 450m in the Bobbejaan fissure to the west (Bobbejaan Mine), versus approximately 100 m on the eastern bank (Frank Smith Mine). The same structure may also account for the abundant beautiful agate assemblage, documented in the Mahura Mutlha channel deposits some 60 km to the north-north-west, which can only be derived from erosion of the Ventersdorp andesitic volcanics.

Initial kimberlite erosion vectors were directed to the west and north, dependent on local conditions, before reversing (after keystone collapse) to the present east-south-easterly direction. Contour and satellite analysis indicates that all observable present-day erosion, extending back to the current watershed, has occurred directly over the scarp, representing approximately 450 m of material removed at the Harts River locality, and some 350 m at the Bellsbank mines themselves.

Diamonds are well-documented to be site-specific and trap-site dependent: larger stones are captured first, a principle illustrated strikingly within a single kilometer at the Williamson mine in Tanzania: granite breccia at the outer contact yields large diamonds at ~2 cpht; the resedimented volcaniclastic kimberlite (RVK) attains grades of up to 20 cpht with a encouraging size-frequency distribution (SFD); while the central Shale Island, after 80 years of mining, remains untouched due to a sugar-fine SFD of no commercial value. The same principle should apply at a landscape scale along the base of the escarpment (as it possibly did at the Lichtenburg sinkholes): no Bellsbank diamond concentrations have been documented in the 40 km of alluvials between the kimberlite source at Bellsbank and the confluence with the Vaal River. It is proposed that the coarse diamonds have potentially been trapped before they could escape downstream, while smaller diamonds have potentially washed downstream and diggers, historically, do not prospect for fine diamonds.

This presentation will present the geological, structural, and geomorphological evidence pointing to the existence of potential diamond trap sites toward the base of Die Kaapse Berg, principally in the form of gullies and sinkholes at the escarpment inflection point, which represents compelling, uninvestigated targets. These targets are contained within the dolomitic shales, siltstones and cherts of the Schmidts drift Subgroup (Transvaal Supergroup)..

The ground beneath the escarpment (referred to in the presentation as "the Strip") was owned by De Beers since the 1952 discoveries until the legislative changes of 2005. Hence, during this time no alluvial prospecting was undertaken. Subsequent tenure holders lacked the intellectual and empirical or expertise to properly evaluate the ground. Following two years of engagement with the DMRE, a prospecting license over the Strip has now been secured and this exciting project can be explored. Information to support this contention is to hand.

The author, for the period of 1998 to 2013, via the entities he was involved with and directed, has the first-hand information and knowledge on this locality.

John Ward

John Ward is a field-oriented geologist with over 40 years working interest in mainly the post-Gondwana geology of southern Africa, with an emphasis on alluvial diamond deposits, primary kimberlite sources and placer gold occurrences. He is currently working in Lesotho, Angola and South Africa, and also participates in an exploration joint venture in each of the DRC and Zimbabwe.

Not a tale of two cities, but of two principal diamond placers (Palaeozoic and Cenozoic) in the southern North West Province, South Africa

John Ward, Independent, Johannesburg; Pierre de Jager, Independent, Douglas
Mike de Wit, University of Stellenbosch; George Smith, Independent, Schweizer-Reneke

The Southern Field (formerly the southwestern Transvaal Field) of the alluvial diamond deposits of South Africa lies in a roughly triangular area (the "Triangle") of the southern North West Province, demarcated by the towns of Wolmaranstad, Schweizer-Reneke and Bloemhof. Alluvial diamonds have been mined in the Triangle since 1908 (Bloemhof area) and 1912 (Schweizer-Reneke area), derived from at least one retained placer and one transient placer along the current northern margin of the Karoo basin. The diamond-bearing gravels in both placers are thin, 0.3-2m thick, and characterised by low grades, 0.25-1.5 carats per hundred tonnes (cpht), but with high (>85%) gem quality of predominantly Type I, commercial white goods averaging around 1 carat/stone (ct/stn). Diamonds larger than 30cts/stn are rare and those above 100 cts/stn are extremely rare. Salient points of the two principal placers are summarised below:
An older, Permian-age, retained littoral placer within the Ecca Group of the Karoo Supergroup comprising a shoreline (mostly intertidal) facies currently lying between 1,370 masl and 1,400 masl around the south-westernmost extension of the Cargonian Highlands and sub-tidal deposits that extend southwards from this maximum transgression level down to about 1,270 masl. The diamonds were sourced from the underlying Permo-Carboniferous glacial sediments of the Dwyka Group (lowermost unit of the Karoo Supergroup) by the Ecca transgressions (and regressions) that fed the Karoo littoral zone from the Southern Field eastwards past Bothaville and Delmas to Carolina. The Dwyka glacial deposits were introduced from

northern and north-eastern parts of southern Africa, potentially tapping pre-Karoo primary bodies (kimberlites) in central and northern South Africa, eastern Botswana and south-western and southern Zimbabwe.

Younger, Neogene transient fluvial placers of probable Miocene (A1 primary gravels), Plio-Pleistocene (A2 terrace gravels) and modern (Late Pleistocene to Holocene) ages demarcate braided, south-flowing watercourses that are right-bank tributaries to the axial Vaal River. There are five major Neogene diamondiferous watercourses (known locally as "runs") in the Triangle, viz., Makwassie (easternmost), Bamboes (largest), Soutpan (Zoutpan), Zevenfontein (central) and London (westernmost). These runs have their headwaters in the shoreline facies of the Ecca littoral placer and thus tap into that older source, as well as the even older Dwyka glacial outwash plain sediments farther downslope that underlie their braidplain courses. Additional diamond sources for the runs are the eluvial-colluvial A0 (Rooikoppie), resistate regolith gravels on the broad interfluves between runs, formed by the deep weathering of underlying Dwyka diamictites and/or Ecca sub-tidal gravels or, more rarely, thin shoreline sediments during the Late Cretaceous to Palaeogene (African Surface). Therefore, the A0 (Rooikoppie) gravels, as laterally persistent as they are, are not, *sensu stricto,* a diamond placer but their minimal overburden, ease of access and 0.25-0.8 cpht grade at about 1 ct/stn make them volumetrically-important, potentially economic deposits in the Southern Field.

Karen Smit

Dr Karen Smit joined the School of Geosciences in 2022, as a Senior Lecturer in Mineralogy and Isotope Geochemistry. Karen is part of the team that set up the world-class isotope labs in the Earth Observatory in Geosciences, and oversees solution isotope analyses of a range of isotope systems such as Rb-Sr, Sm-Nd, Lu-Hf, Pb, Fe and Ca.

Between 2014 and 2020, she held Postdoctoral and Research Scientist positions at the Gemological Institute of America (GIA) in New York. She obtained her PhD from the University of Alberta (2013), and a MSc from the University of Cape Town (2009).

Her research involves the sample-based investigation of geological processes in the deep Earth. This includes studies that use mantle xenoliths and diamonds to investigate the mineralogical properties of the deep Earth; tectonic processes that affect the mantle and result in the stabilisation of continents; and using diamonds as the ultimate tracer of the deep carbon and nitrogen cycles.

Spectroscopic analyses of Lichtenburg alluvial diamonds compared to diamonds from regional kimberlites

Karen V. Smit[1], Lamorna Gee[2], Ingrid Chinn[3]

[1]School of Geosciences, University of the Witwatersrand

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[3]De Beers Group Services

Our study comprises a suite of 44 coloured diamonds from the Grasfontein diggings at Lichtenburg, including yellow, orange, brown, pink and green. To determine the defects responsible for diamond colouration, we performed UV-Visible spectroscopic analyses in combination with FTIR analyses of the whole stones at GIA in Johannesburg. In order to quantify the amount of nitrogen defects in each of these diamonds, and determine mantle residency temperatures for the various coloured diamonds, unsaturated FTIR spectra will be collected on a Thermo Nicolet iN10 instrument at the School of Geosciences.

Eleven yellow 'Cape' diamonds contain the N3 (VN_3) and associated defects at 415 nm. Yellow colouration in four of the diamonds result from isolated substitutional nitrogen (C centre, N_S^0) with an absorption ramp from around 730 nm to the intrinsic diamond absorption edge at around 200 nm, and a 1344 cm^{-1} peak in FTIR. Diamonds with abundant N_S^0 typically account for less than 0.1% of natural diamonds (Breeding et al., 2020). Preservation of N_S^0 in natural diamonds is normally explained through either short mantle residency times or storage at T < 700 °C (Taylor et al., 1996), whereas most cratonic diamonds are billions of years old and resided at >1000 °C (Smit et al., 2022, Nimis et al., 2022). Eight yellow-orange diamonds are not coloured by N_S^0 and instead by the unidentified 480 nm band.

These diamonds appear to be Type IaA, but will be confirmed with unsaturated FTIR spectra.

Ten pink-brown diamonds are coloured by the broad absorption peak at 550 nm, and four brown diamonds display a continuous absorption ramp from the IR to the UV, that is common in brown diamonds coloured by absorption due to vacancy clusters (Fisher et al., 2009). Two green diamonds are coloured by a combination of the GR1 (V^0 at 741 nm) and H3 (NVN^0 at 503.2 nm) defects that may be related to irradiation and heating/annealing after diamond deposition at Lichtenburg.

CO_2 peaks are observed in the FTIR spectra of six diamonds and are not limited to a particular diamond colour, but occur across the range of colour categories – yellow Type Ib diamonds, pink 550 nm diamonds, deformed brown diamonds, and yellow-orange diamonds coloured by the 480 nm band.

The primary kimberlitic source/s of the Lichtenburg alluvial diamonds remains undetermined. The FTIR characteristics and mantle residence temperatures of rare coloured diamonds from Lichtenburg will be used to compare with published diamond data from known kimberlites in the region (Helam, Palmietfontein, Palmietgat, Cullinan) to evaluate whether these regional kimberlites may have contributed to the Lichtenburg alluvial deposit.

Khodani Matshusa

Khodani Matshusa is a leading expert in geoheritage and geotourism, holding the first PhD in this field by a Black African. He has significantly impacted research, policy, and governance through his scholarly work and leadership in funded projects with organisations like UNESCO. With 15 years of experience in research, academia, mining, and consulting, he currently leads Africa Chair on Geo-Mining Heritage, Geotourism and Resilience at UNISA, fostering collaborations and mentoring students while promoting geoconservation, and social justice across sub-Saharan Africa.

Preserving Bakerville's geo-mining heritage

Khodani Matshusa[1,2]

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The extensive geo-mining heritage of Bakerville, accumulated over 100 years of mining operations, has yet to be documented and made accessible to the mining industry, scientific community, and the public. This historic diamond geo-mining heritage is spread throughout Lichtenburg, particularly at Bakerville and encompasses various diggings, portholes, and remnants of the old mining offices. Despite the significance of this geo-mining heritage, no dedicated study has been undertaken to unlock and preserve this invaluable knowledge and national assets. Consequently, this study aims to address this knowledge deficit by documenting geo-mining heritage with the purpose of uplifting local communities through geoconservation and geotourism. These efforts will assist to transition from mining towards sustainable mine closure.

Mike de Wit

Born in the Netherlands in 1952. Mike obtained his geology degree from Trinity College, Dublin, and MSc degrees from the Universities of Pretoria (Geophysics) and Reading (Sedimentology) and completed a PhD from the University of Cape Town in 1993.

He started his career with the Geological Survey in 1976 where he spent two years in applied geophysics in the Lichtenburg area. The following 29 years he worked for De Beers in diamond exploration in various parts of Africa including three years at the Anglo-American research laboratories, and ended up as exploration manager for Africa for De Beers. From 2007 until 2018 he worked for several junior exploration companies in the DRC, Botswana and South Africa, and is now semi-retired but pursuing his personal interest in writing an atlas of all alluvial on-shore diamond deposits in South Africa and southern Namibia.

In 2007 he was appointed as Honorary Professor in geology at the University of Pretoria and in 2019 he became a Research Fellow at the University of Stellenbosch. He published several papers and two books.

A depositional model for the Bakerville gravels and the sources of its diamonds

Mike de Wit

Diamond-bearing gravels of the Lichtenburg – Ventersdorp area are associated with sinuous north-south orientated ‘runs’ that occur exclusively on a flat erosional surface comprised almost entirely of Malmani Subgroup dolomites (Transvaal Supergroup). This unconformity, which developed over a period of 80 Myr prior to deposition of the Pretoria Group sediments, was exhumed in pre-Karoo times, and again in post-Gondwana times. Glacial pavements and isolated remnants of thin Karoo sediments are also found across this poly-phase erosional surface. The coarse-grained gravels (texturally diamictites) that make up the runs and within sinkholes, directly or indirectly linked to the runs, have been mined since 1926 and have produced some 8.5 million carats of diamonds. The runs are narrow, elongated, positive ridges that meander across the dolomite surface. They are up to 30 km long, between 80 m and 300 m wide and up to 20 m high. These have been interpreted by previous workers as post-Gondwana drainage deposits linked to southward-flowing Cainozoic river systems. However, no fossils or artefacts have been reported in almost 90 years of mining. Recently, based on new field evidence, geomorphological studies, and age-dating from inclusions in diamond and zircon analyses, indicate that the runs are paleo-eskers that were formed during final deglaciation of the Permo-Carboniferous Dwyka continental ice sheet. The eskers represent the infillings of ice-walled stream channels and record deposition of poorly-sorted sediment in subglacial drainage networks. Diamictites and their associated internal structures are interpreted as outwash fans or deltas deposited at the front of the glaciers, and fed by the eskers during ice retreat. Two populations of agates within the diamictites are linked to two separate volcanic units of the Pretoria

Group. The youngest ages of detrital zircons from the diamictites are of Kibaran age (ca. 1 Ga), whilst diamond inclusions from the eskers support a Cambrian (c. 500 Ma) primary source. The absence of diamonds from Mesozoic kimberlites, and of Cenozoic fossils, supports the conclusion that the runs are of Karoo age. The Lichtenburg-Ventersdorp area is characterised by two diamond populations. A dominant population of generally lower-value diamonds is restricted to only a few farms north of Lichtenburg, and a lesser population of higher-value diamonds is spread across the Lichtenburg – Ventersdorp area. Nearly 80% of the 8.5 million carats produced in the Lichtenburg – Ventersdorp field have been derived from four farms north of Lichtenburg, and these are predominantly derived from the former population. These four farms also host the major 'potholes' that have been the sources of most diamonds. The presence of unabraded kimberlitic minerals with unique chemistries, clays with ultramafic signatures, some extraordinary high-mine grades associated with these potholes, in addition to the abundance of poor quality and often fragile diamonds and bort within this diamond population, advocates that these 'potholes' are associated with deeply weathered kimberlite pipes (e.g. Pienaars and Welverdiend potholes) and dykes (e.g. King's, Malan's and Van Wyk's 'potholes') of the Bakerville kimberlite cluster. The higher value diamonds that are present across the area are modelled to have been derived from the Mesoproterozoic Cullinan Mine and have been distributed by fluvial and glacial sedimentary systems.

Ponani Mthembi

I am a Chief Scientist at the Council for Geoscience, holding an MSc in Applied Geology from the University of Cape Town. With 18 years of experience in geological mapping and research, I am currently based at the Polokwane regional office. My work focuses on interpreting complex geoscientific data and contributing to regional and national geological programmes that support informed decision-making and sustainable development.

Over a decade of advancing Earth Sciences: Insights from the Multidisciplinary Integrated Geoscience Mapping Programme, Northwest and Northern Cape Provinces, South Africa

P. Mthembi
Council for Geoscience, Polokwane, South Africa

This decade-long geological mapping programme was designed as a systematic, multidisciplinary initiative to improve regional geoscientific understanding while supporting mineral exploration, land-use planning, and infrastructure development. The programme was initiated in the North West Province with a focus on mapping alluvial diamond-bearing gravels across 1:50 000 map sheets to generate new mineral deposit targets. It subsequently expanded northwards into the Northern Cape, where its scope broadened to include the characterisation of key mineral systems such as diamonds, iron, manganese, asbestos, and tiger's eye within the geological framework of the Griqualand West Basin and its surrounding regions. A central objective of the programme is to identify and map Cenozoic fluvial deposits that may have potentially transported alluvial diamonds, while also improving correlations between the Griqualand West and Transvaal Basins.

Field mapping progressed in a phased, northward-expanding approach, beginning in the Prieska area (2016/2017), followed by the Kuruman and Postmasburg regions (2018/2019), Douglas (2020/2021), the manganese-rich Hotazel area (2022/2023), and the Olifantshoek region along the Langeberg quartzite ridges (2022/2023). The last phases (2024/2025-2025/2026) extend towards Vryburg, with emphasis on the Cenozoic landscapes and dolomitic terrains of Griqualand West. Since 2018, the programme has produced more than 70 geological maps, significantly strengthening regional geological datasets. The mapped regions are characterised by limited bedrock exposure, with dominant lithologies comprising dolomites of the Campbell

Rand Subgroup, often overlain by extensive Cenozoic deposits. Prominent structural and geomorphological features such as the north-south trending Olifantshoek quartzite ridgesmark the margin of the Kaapvaal Craton and the boundary of the Griqualand West Basin. Widespread aeolian sands, including linear dunes, sand ramps, climbing dunes, and sheetwash colluvium, record a complex history of fluvial deposition during the Late Cretaceous to early Tertiary, followed by significant aeolian reworking during the Pliocene and Quaternary.

Overall, the programme represents a comprehensive and evolving mapping effort that enhances understanding of stratigraphy, structure, and surficial processes in a largely underexposed region. Its outputs provide a critical foundation for mineral exploration particularly for alluvial diamonds and manganese while also delivering valuable geoscientific data for research, environmental management, and sustainable development.

Puleng Nthebe

Puleng Nthebe is an MSc candidate in the School of Geosciences at the University of the Witwatersrand, South Africa. Her MSc research focuses on the thermochemical evolution of the lithospheric mantle beneath the southeastern margin of the Kaapvaal Craton using mantle xenoliths from Lesotho. She also has a strong research interest in diamond geology and spectroscopy, applying techniques such as Fourier Transform Infrared (FTIR) and Ultraviolet–Visible (UV–Vis) spectroscopy to investigate diamond formation, mantle residence histories, and post-growth processes.

Before commencing her MSc, Puleng worked as an Analytical Technician at the Gemological Institute of America (GIA), where she gained experience in analytical techniques for diamond characterisation. She is a registered Candidate Natural Scientist with SACNASP and a student member of the Geological Society of South Africa (GSSA). Her research interests include mantle petrology, diamond genesis, mineral spectroscopy, and the evolution of cratonic lithospheric mantle.

Spectroscopic Characterisation of Palmietgat Diamonds

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The Palmietgat kimberlites comprise a cluster of six Group I kimberlite pipes (K14E, K14W, K15, K16E, K16C and K16W) located approximately 70 km north of Pretoria within the centre of the Bushveld Igneous Complex (Webb et al., 2011). The Palmietgat kimberlites were emplaced during the Late Cretaceous (~100 Ma), and intrude through Mid-Jurassic Karoo basalts and Clarens Formation sandstones (Webb, 2009). Despite their unique geological setting, the Palmietgat kimberlites and their mantle cargo remain poorly characterised.

Our study focuses on a suite of 102 diamonds (0.06–3.13 ct) recovered from the K16E, K16C and K16W kimberlite pipes. The diamonds were characterised using Fourier Transform Infrared (FTIR) spectroscopy, Ultraviolet–Visible (UV–Vis) absorption spectroscopy, and optical microscopy. FTIR analyses show that all diamonds are Type Ia, containing aggregated nitrogen defects in the form of A centres (pairs of nitrogen atoms) and B centres (four nitrogen atoms surrounding a lattice vacancy), with variable nitrogen concentrations and aggregation states. Nitrogen aggregation isotherms were calculated using two mantle residence-time models: an Archean model (3 Gy) and a Bushveld model (2.06 Gy). Under the 3.00 Gy residence-time model, the majority of the diamonds plot between 1100 and 1150 °C, whereas the same diamonds correspond predominantly to 1150–1200 °C under the 2.06 Gy model. A subset of predominantly Type IaA diamonds plots below 1100 °C, and another subset of highly aggregated Type IaB diamonds plot at temperatures greater than 1200 °C, reflecting warmer mantle residence conditions.

In near-colourless diamonds, UV–Vis spectroscopy identified the N3 and N2 centres (VN_3) at 415 and 478 nm, indicating well-aggregated nitrogen and prolonged mantle residence. Isolated substitutional nitrogen (C centres) was identified in some yellow diamonds and reflects incomplete nitrogen aggregation, whereas a broad 550 nm absorption band, together with vacancy cluster defects in brown diamonds, is consistent with plastic deformation and post-growth modification of the diamond lattice.

Optical microscopy reveals growth features, including triangular growth plates, shield-shaped and serrate laminae, and hillocks, together with dissolution features such as trigons, terraces and corrosion sculptures, as well as deformation lines. Several primary growth surfaces exhibit evidence of subsequent dissolution, indicating repeated episodes of crystal growth and resorption. Collectively, these features record diamond crystallisation, mantle metasomatism, plastic deformation during mantle residence, and modification during kimberlite ascent and emplacement.

This integrated spectroscopic and morphological characterisation provides the first comprehensive dataset for Palmietgat diamonds. Our results establish a framework for future investigations of mineral inclusions, diamond formation conditions, mantle metasomatism and the influence of regional tectono-magmatic processes on the evolution of the Palmietgat lithospheric mantle.

Refilwe Monoko

Ms Refilwe Monoko is a Specialist Geoscientist at the Council for Geoscience and a trained mapping geologist, with cumulative 20 years' experience in geoscience and management. She is also the first known Black woman to map and publish detailed geological maps in South Africa. She holds a master's degree in geology from the University of Witwatersrand, a certificate in the Global Executive Development Programme from GIBS) and certificates in Business Analytics as well as Property Development and Investment (distinction – University of Cape Town). She was an executive manager at the CGS for 6 years. In her previous career, Refilwe successfully contributed to various programmes of national importance including but not limited to the Karoo Deep Drilling programme, Exploration Strategy of South Africa and The Mine Closure Strategy to count a few. She was the co-developer of the South Africa's National Multidisciplinary Geoscience Mapping Programme (for which she received a couple of excellence awards) which is still being implemented in the Republic.

Outside work, Refilwe is a life coach, an author, a speaker and a teacher.

Alluvial diamond prospects in the North West Province, South Africa

Refilwe Monoko

Council for Geoscience

The 1867 alluvial diamond rush near Hopeville on the Orange River in the platinum province of North West led to the discovery of the Lichtenburg alluvial diamond field almost 60 years later, as well as subsequent discoveries. Although there has been intense mining coupled with progressive diminishing production, it is accepted that alluvial diamond mining forms an essential part of the mining value chain. Progressive mining value chains begin with high-quality pre-competitive geoscience information and knowledge. The Council for Geoscience (CGS) has been a critical contributor of such information and knowledge. In 2015, under the auspice of the erstwhile Department of Mineral Resources, the CGS implemented geoscience mapping campaigns to identify the extent and mineral potential of the alluvial diamond fields in the North West Province using high resolution geological, geophysical and remote sensing data. Mining is no stranger to the province and to this end, several prospective areas were selected using these significant data as areas of detailed follow up studies.

Whereas alluvial diamond operations remain largely concentrated in the North West Province, most of the large operations of diamondiferous alluvial gravels have been mined out. However, it is reported that there are still unmapped deeper alluvial gravels which may be host to high-value diamonds. Although no one can predict if the glory days of alluvial diamond mining will return, it is plausible that the provision of detailed geoscience information from national programmes such as the Integrated Multidisciplinary Mapping Programme of the CGS in collaborations with key stakeholders as well as rapid-response innovative geoscience techniques, could potentially unearth additional discoveries and boost diamond production sustainably. Future discoveries of alluvial diamonds will contribute to uplifting the local economies, improving quality of life and creating hundreds of jobs to curb the high unemployment rates in the province, even from artisanal alluvial diamond mining activities. The relatively low environmental impact of alluvial diamond mining creates a great opportunity for the coexistence of mining and agriculture. This coexistence can also contribute to the reduction of mining ghost towns and encourage longevity of economic activities in small communities.

Simon Sebothoma

Simon Sebothoma is a Geophysicist at the Council for Geoscience (CGS). He has been working for the Council for Geoscience for over 10 years. He holds a degree (BSc) in Geology and Physics that he obtained from the University of Johannesburg, BSc (Hons) in Geophysics and MSc in Geophysics from the University of the Witwatersrand.

Geophysical characterisation of alluvial gravel deposits near Lichtenburg, North West Province, South Africa

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The alluvial diamond mining operations at Lichtenburg area in North West Province are currently facing a decline. To stimulate and support renewed mining activities the Council for Geoscience (CGS) launched a target generation project funded by Department of Mineral Resources and Energy (DMRE). The project formed part of CGS integrated and multidisciplinary geoscience mapping programme. One of the objectives of the project was to investigate the unexploited potential alluvial diamonds in Lichtenburg area. The investigation included 1.) integration of high resolution airborne magnetic dataset with geological dataset (known runs) to identify any possible correlation between the magnetic lineaments, known runs and diamondiferous potholes, 2.) target generation for follow-up ground geophysical study, 3) Locating new potential alluvial diamond deposits (runs), 4) developing new methodologies for alluvial diamond exploration. The datasets used included high resolution airborne magnetic and geological (known runs and diamond occurrences) datasets. Ground geophysical mapping methods used for follow–up ground geophysical study included, Gravity, Magnetic, Electrical Resistivity Tomography (ERT), Seismics (Refraction and Reflection). Integration of the known runs and magnetic lineaments (dykes and faults) datasets indicate good correlation; it indicated that most of the known runs are located along or above the magnetic lineaments. Several potential runs were identified. These potential runs extend from the known runs, and they were traced using integration approach of magnetic lineaments and potential drainage systems interpreted from the Digital Terrain Model

(DTM) dataset. Two study areas, namely, Itsoseng and Sheila study areas were selected for further follow-up ground geophysical study. The Itsoseng and Sheila study areas transect the magnetic lineaments (D31 and D71) that are suspected to be potential undiscovered runs. Follow–up ground geophysical studies indicate the existence of structural features that are suspected to be buried river channels (R31 and R71) that are located above the magnetic lineaments (D31 and D71). The ground magnetic method mapped the targeted magnetic lineament (D31) at Itsoseng study area as having both negative and positive magnetic polarities. At Sheila study area, the ground magnetic method mapped the targeted magnetic lineament (D71) as having only positive magnetic polarity. The gravity method mapped the targeted magnetic lineaments (D31 and D71) at Itsoseng and Sheila study areas, respectively as having low gravity responses. ERT mapped the magnetic lineaments (D31 and D71) in both study areas as vertical low resistivity trough-like features that transect the bedrock. Refraction seismic mapped the magnetic lineaments (D31 and D71) in both study areas as vertical low velocity trough-like features that transect the bedrock. Integration of known runs with the magnetic lineaments proves to be best exploration approach for alluvial diamond exploration. This study showed that the runs follow magnetic lineaments. The findings of this study will add value to the ongoing alluvial diamond studies and will also enhance knowledge and skills of the experts in this field.

Tania R Marshall

Tania Marshall is currently the Executive Manager of the Geological Society of South Africa. She has been actively, and continuously, involved in the diamond and gemstone exploration/mining industry since 1985. She has a PhD from the University of the Witwatersrand. In 1996 Dr Marshall founded Explorations Unlimited and has been involved in consulting and contracting to numerous South African and international exploration and mining companies until December 2026. She is also an Honorary Adjunct Professor at the Department of Mining Engineering at the University of the Witwatersrand.

Dr Marshall is a Fellow (with Chartered Status) of the Geological Society of South Africa (GSSA), a Member of the Southern African Institute of Mining & Metallurgy (SAIMM), a life Member of the Geological Society of Africa (GSAf) and is registered with the South African Council for Natural Scientific Professions (SACNASP). In addition, she is a past chair of the SAMCODES Standards Committee and remains an active member of the SAMREC, SAMVAL and SAMESG Committees, chairs the SAMREC Diamond Working Group and is a Past President of the GSSA.

Some aspects of the geology of the karst-hosted alluvial diamond deposits of the Ventersdorp District

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Diamonds have been recovered from the karst-hosted alluvial deposits of the Ventersdorp district from at least the early 1900s. Most of the mining has been from artisanal as well as small scale (ASM) operations. Etruscan Diamonds (Pty) Ltd (2002-2008) and Rockwell Diamonds (2011-2014) mined on a much more mechanised scale, bringing modern exploration and mining techniques to bear.

The preferred geological model is one of deposition in a karst environment where the dolomite walls of the host-rock are vertical; periodic subsidence has taken place during deposition; and deposition has taken place over a long time (since, at least, the Permian) resulting in a build-up of a very thick gravel sequence. The gravel stratigraphy comprises an upper gravel horizon (UGP) and a lower gravel unit (LGP) that are both diamondiferous, separated by a poorly mineralised fine-grained pebble-clay unit (PCP). The LGP, which is characterized by a predominance of quartzite over chert clasts, may be clay-rich or clay-poor, with the clay-poor varieties being the primary exploration target due to their higher average grades.

Karst is terrain with distinctive landforms and drainage arising from greater rock solubility in natural waters than elsewhere. Solution is not always the most prevalent process in karst, nor is it necessarily the most dominant one, but it does play a more important role here than in other kinds of landscapes. Its most critical effect lies in the enlargement of underground voids, causing increased permeability of the rock. As more water passes through the rock, the voids become large enough to become caves.

In normal landscapes, small streams in small valleys join to become large rivers in large valleys. In karst, this harmonious pattern is broken up by the development of small, centripetal drainage basins and closed depressions take over the landscape to varying degrees. Superficially it lacks organization and the drainage system has to be sought underground. In karst areas, the total or partial absorption of a watercourse is known as a swallow hole, watersink, or sinkhole.

Though structural and lithological considerations are very important, the regions with the greatest number of sinkhole-type swallowholes are those of both present- and recent- glaciation. Where thick soils or superficial (glacial or alluvial drift) deposits cover karst rocks, dolines can develop through spasmodic subsidence and more continuous piping of these materials into widened joints and solution pipes in the bedrock beneath

Mineralisation is largely confined to the gravel packages in-filling karst caverns etched out of the chert-rich dolomites of the Malmani Group. The clay-poor Lower Gravel Package and Upper Gravel Package units are considered to be the major exploration targets as the diamond grades encountered in these units have, historically, supported commercial mining ventures. Elevated grades have also been associated with the layer of colluvial manganese nodules located at the top of the sequence – this unit is not everywhere present but has been highly sought after by the ASM operators.

Airborne and ground gravity surveys (and supported by extensive drilling) indicate that the karst system trends roughly in a NW-SE direction across the properties and is offset by a number of structural features. There appears to be a succession of sinkholes connected by a series of linkage channels (which pattern is typical of allogenic streams). The overall length of the karst system is in excess of 6,000m and channel widths vary from 135-385 m.

Over the period 2006 to 2018, some7M m^3 of gravel has been processed from various localities, to recover +120M ct of diamonds at an average grade of 1.7-

1.8ct/100m^3. Diamond values for the same period averaged around USD600/ct (in 2018). Distinct variations in grade and value characterise different runs in the Ventersdorp district. Alluvial gold has been noted in the diamond concentrates and manganese is known to occur on the dolomite-rich portions of the Malmani dolomite in the Ventersdorp district.

POSTER PRESENTERS

Dieketseng Boshomane

Dieketseng Boshomane is an emerging entrepreneur, researcher, and geoscientist dedicated to empowering others through knowledge. As the Marketing and Branding Officer of FutureZA Learning, a tutoring business, she promotes academic support and career guidance to boost learners' confidence and performance. She holds a BSc (Hons) in Geology and is pursuing her Master's degree at the University of Pretoria, focusing on innovative carbon sequestration methods in mining to reduce environmental impact. Dieketseng advocates for analytical thinking and problem-solving as essential skills for all students. Through FutureZA, she aims to bridge the gap between potential and performance, utilizing education to drive transformation in academics, careers, and society.

Lab scale offsetting of CO_2 emissions by air capture in sample fine residue dumps from Cullinan Diamond Mine, South Africa: Rates, controls, TSF stabilisation, and prospects for carbon neutral mining

Dieketseng Boshomane

The transition toward carbon neutral mining requires innovative approaches for large scale carbon capture and sequestration. Kimberlite tailings, the waste product of diamond mining possess a significant potential for mineral carbonation due to their ultramafic composition and reactivated mineral phases such as brucite and serpentine. This study investigates the optimization of passive mineral carbonation by enhancing the flow of CO_2 in fine residue tailings from the Cullinan Diamond Mine, South Africa, through lab scale simulations.

To enhance CO_2 capture and sequestration efficiency under field simulated conditions, this research explores the interaction of CO_2 enriched water with the tailings, designed to mimic rainfall and enhanced sub surface airflow of CO_2 into the tailings. Sub surface aeration is facilitated by the introduction of perforated PVC pipes installed across the tailings profile to address the limitations on CO_2 diffusion. The primary objective of the study is to quantify the rates, depth and long-term chemical and physical stability of carbonate formation under these controlled conditions, and examine how variables such as moisture, mineral activity, and diffusion affect the rates of mineral carbonation. The study further probes into how carbonates formed from mineral carbonation contribute to cementing the tailings, therefore increasing the stability of TSFs.

By quantifying these controls and rates, this research aims to provide a basis for scaling passive carbonation strategies, offering a feasible technique for diamond mines to offset CO_2 emissions and move to towards carbon neutrality.

The findings are expected to contribute to the development of a low-cost approach for incorporating in-situ carbonation into mine closure plans, carbon credit systems and broader carbon neutral mining practices. Ultimately, the research seeks to support safer tailings facilities and more sustainable mining practices within the diamond mining sector.

Lino Keatsitswe

Lino Keatsitswe is an undergraduate Geology student at the University of Botswana with a strong interest in copper mineralization in the Kalahari Copperbelt. His current research focuses on the petrography and geochemistry of host rocks and mineralized veins in the Karakubis area.

He has gained practical experience through geological core logging, structural measurements, and mineral identification during his field attachment with Kavango Minerals. His work involved logging into multiple drillholes and analyzing lithology, alteration, and structural features to better understand the controls on mineralization. Lino is particularly interested in how geology can be used to improve mineral exploration in areas covered by Kalahari sands. He aims to develop practical skills that connect academic research with real exploration work in Botswana's mining industry.

Petrography and geochemistry of host rock and veins with variable copper mineralization in Karakubis, Kalahari Copperbelt, Botswana

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The Karakubis area, located within the Kalahari Copperbelt in northwestern Botswana, is an underexplored region with significant potential for sediment-hosted copper-silver mineralisation. Most investigations within this belt have focused on mineralisation associated with redox boundaries, while comparatively less attention has been directed towards vein-hosted mineralisation. This research aims to improve the understanding of vein-hosted copper mineralisation in Karakubis by analysing host rocks, vein systems, and structural features using petrographic and geochemical methods.

Six diamond drillholes (KCBDD002 to KCBDD007) were logged. The lithologies, mainly Ghanzi Group arkosic sandstone, sub-arkose, and laminated siltstone, show signs of hydrothermal alteration, including chlorite, hematite, and limonite staining, carbonate veining, and bleaching, indicating fluid movement.

Structural features are well developed and include fractures, shear zones, and quartz-chlorite veins. These structures appear to control fluid flow and the loci of mineralisation. Copper mineralisation occurs as fine disseminations within the host rocks and within quartz-rich veins. The predominant sulphide minerals are chalcopyrite, bornite, and pyrite, occurring as small blebs, disseminated grains, and cubic crystals. Occasionally, prismatic quartz crystals are observed, indicating crystallisation from hydrothermal fluids within open spaces.

The variation observed in copper mineralisation appears to be significantly influenced by the structural settings, mineral assemblages, and rock textures.

Regions with well-formed veins and fractures tend to display elevated concentrations of sulphide minerals. These findings suggest a multi-stage mineralisation process, initiated with early sulphide formation and subsequently influenced by hydrothermal fluids travelling through structural conduits.

The findings demonstrate that Karakubis shares notable similarities with other mineralised zones within the Kalahari Copperbelt, particularly in how structural features influence mineralisation. This study offers valuable insights that can inform future exploration, particularly in areas obscured by Kalahari sands, where surface observations are limited. An improved understanding of the controls on mineralisation in this region can enhance targeting precision and exploration efficacy in analogous geological settings.

Mmamaraka Nkuna

Mmamaraka Nkuna is a highly motivated and academically accomplished 22-year-old Earth science professional based in Pretoria, South Africa. She holds a BSc in Geology and is currently pursuing her Honours degree at the University of Pretoria. Passionate about intersecting traditional geosciences with modern technology, Mmamaraka has actively expanded her expertise into Machine Learning, data analysis, and geographic information systems (GIS), utilizing tools such as ArcGIS Pro, QGIS, Python, SQL, and R.

Industry & Technical Experience: She has gained valuable hands-on mining experience through geology vacation work with Exxaro at both the Grootegeluk and Leeuwpan coal mines. Her technical versatility is further proven by her various roles as a university chemistry lab assistant, data analyst, and her recognition by ESRI South Africa for winning a best StoryMap competition.
Leadership & Engagement: An exceptional student leader, Mmamaraka serves as the Chairperson for the NAS Faculty House (NATHouse), where she manages budgets, events, and stakeholder relations while leading a 12-member team. Her peers and university departments have consistently trusted her as a student liaison, academic officer, mentor, and Golden Key panel member.
Communication & Soft Skills: Multilingual and an adept public speaker, she speaks English, IsiZulu, Northern Sotho, and Setswana fluently, alongside conversational

Afrikaans. She is known for her adaptability, emotional intelligence, and ability to collaborate seamlessly across diverse environments.

Mmamaraka combines a strong foundation in geological engineering with forward-thinking technical skills, making her a dynamic asset to the evolving Earth science and data modeling sectors.

The importance of ML in geology: Detecting pyrite (FeS_2) nodules in coal seams using machine learning

Mmamaraka Nkuna

Machine Learning has become an indispensable tool in the geosciences. In this project machine learning is used to detect pyrite nodules. What are pyrite nodules and why should they be detected? Pyrite (FeS_2) often called "fool's gold", commonly found in coal seams. The nodules can increase sulphur content which causes environmental issues such as acid mine drainage and increase the cost of processing coal. Detecting pyrite nodules would improve coal quality control, reduce emissions and aid mine planning. Machine learning will be used on the mining models, to implement a convolutional neural network (CNN) for the automated detection of pyrite nodules in coal using hyperspectral imaging data, leveraging spectral-spatial feature learning to improve accuracy in mineral identification and classification. This study demonstrates the potential of convolutional neural networks (CNN) combined with hyperspectral imaging for the automated detection of pyrite nodules in coal. By learning both spectral and spatial features, the model enables accurate, non-destructive identification of pyrite, reducing reliance on manual analysis and improving coal quality control. This approach can enhance environmental monitoring and support more efficient coal processing and mine planning.

Mphanama Thangeni

Mphanama Thangeni is a geoscientist with a background in mining and environmental geology and a strong interest in base metal mineralisation, particularly copper sulphide systems. Mphanama holds a Master's degree in Mining and Environmental Geology and is currently completing a PhD focused on the occurrence and distribution of copper sulphide mineralisation in the Mutale Copperfields of the Soutpansberg Group. His research is largely field-based and draws on geological mapping, observations from historical mine workings and waste rock dumps, as well as mineralogical and geochemical data. A key focus of the work is understanding the geological and structural controls on mineralisation and how this knowledge can support resource evaluation and responsible mining. More broadly, Mphanama's interests include applied geochemistry and the environmental considerations associated with base metal exploration and mining.

Occurrence and Distribution of Copper-Sulphide Mineralisation in the Mutale area, Soutpansberg Group, South Africa

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Lippe (TH OWL), University of Applied Sciences, Germany

The Mutale Copperfield of the Soutpansberg Group hosts numerous documented copper occurrences and historical mine workings. This study integrates petrography, cathodoluminescence, fluid inclusion microthermometry, Sentinel-2 multispectral imagery and Copernicus DEM-derived structural analysis to characterise mineralisation controls and identify areas with geological characteristics favourable for copper mineralisation.

Petrographic, cathodoluminescence and fluid inclusion analyses indicate that copper mineralisation is associated with quartz-carbonate veining, epidotisation and multiple hydrothermal events. Ore assemblages comprising chalcopyrite, covelline, specularite, magnetite, malachite, azurite and cuprite suggest primary copper mineralisation followed by supergene oxidation. Fluid inclusions record low- to moderate-temperature saline hydrothermal fluids, with quartz-hosted inclusions yielding homogenisation temperatures of approximately 125–160°C and salinities of 3–10 wt.% NaCl equivalent.

Principal Component Analysis (PCA) of Sentinel-2 imagery showed that the first three principal components (PC1–PC3) accounted for 90.3% of the total spectral variance. Maximum Likelihood classification mapped five major lithological units, while lineament extraction from the Copernicus DEM revealed a dominant NE–SW structural trend, with most lineaments oriented between 60° and 75°, consistent with

regional Soutpansberg Group structures. Historical mine workings are predominantly associated with basalt and basalt–red quartzitic sandstone contacts and are concentrated within fault zones and areas of high lineament density, indicating strong lithological and structural controls on mineralisation.

The integration of lithological, hydrothermal alteration and structural datasets confirms the geological controls associated with known copper occurrences and identifies additional areas exhibiting similar geological characteristics that may warrant further exploration.

Kimberly Olorato Majahane

Kimberly Olorato Majahane is a final-year Geology student with a research focus on sediment-hosted copper systems in the Kalahari Copper Belt, Botswana. Current work centres on the petrographic and geochemical characterisation of red and green siltstones from the Karakubis area and their implications for mineralisation.
Research experience includes field-based sampling, core logging, thin-section petrographic analysis, and geochemical data interpretation. Analytical work has involved sample preparation, including crushing, pulverising, and grain size separation, as well as laboratory-based petrographic analysis and integration with geochemical datasets.
An industrial attachment at Kavango Minerals provided exposure to exploration workflows within the Kalahari Copper Belt, including drill core handling, logging, and mineralisation assessment in an active exploration environment. This experience strengthened the application of academic methods to industry-focused mineral exploration.
Research interests include sediment-hosted stratiform copper deposits, fluid-rock interaction, redox geochemistry, and the integration of petrographic and geochemical data in mineral exploration models. Future work aims to further constrain the controls on copper mineralisation in fine-grained sedimentary systems and contribute to improved exploration targeting within emerging copper provinces

A petrographic and geochemical analysis of the siltstones of the Karakubis area; implication for mineralization.

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The Kalahari Copper Belt is a key emerging copper province, but controls on lithological variability in fine-grained units are poorly understood. This study presents petrographic and geochemical analyses of red and green siltstones in borehole KCBDD006 in the Karakubis area. It aims to explain why green siltstone is mineralised while red siltstone remains barren, despite their proximity. Petrography examines grain composition, fabric, and diagenetic features, focusing on mineral phases that indicate redox conditions, such as iron oxides and sulphides. Geochemistry assesses elemental differences, especially redox-sensitive elements like Fe. Initial results show that red siltstones are hematite-rich, indicating oxidation, while green siltstones contain reduced minerals such as chlorite. The transition marks redox boundaries from diagenetic shifts. Combining datasets clarifies how these lithologies differ and influence mineralisation, providing insights into diagenetic processes and mineralisation potential.

Sphiwe Mtiya

I was born in Eastern Cape at the location called Dimbaza in King Williams, and grew up and attended grade 1-grade 5 from 1981 to 1987 at Arbor Primary School in Witbank. I attended my High School level at Hewu High School in Sawutiya village in Whittlesea and this was 1988 to 1992.

From 1993-1999 I was doing voluntary work at Apostolic Faith Mission Church in Witbank.

From 2000-2005 I studied MBCHB in Medunsa financial circumstances hit hard and I left school to start my own business.

In 2010 I qualified as a Franchisee in Vodacom.

In 2012 Mr Ben Cronje introduced me to the de Beer Family who owned DB Mining and Exploration which was a Diamond Mining Company

2012 - 2026 Helped turn D.B. Mining into a more rounded company with Mining Rights and assisted in adding new minerals, Like Manganese, which are currently in demand in the world markets and helped commission new reports with CGS and MINTEK amongst others.

Experiences and frustration of a Small Miner's attempts to develop opportunities and jobs in the South African Diamond (and minerals) sector

Siphwe Mtiya (Entrepreneur, Business Developer)

The author of this Abstract and presentation to follow, has spent **14** years (since 2012) endeavouring to secure legitimate opportunities to develop small mining operations in the North West Province with a focus on the Bakerville area. Every effort to do so has been slowed down by multitude of challenges, blockages, the bureaucracy, red tapes and failure to assist genuine attempts to unlock the huge remaining potential of South Africa's minerals treasure trove.

The Government Policies, Legislations, Codes of Good Practice at IDT to support Small Scale Miners (SMC) to unlock their Projects. Funding Institutions such as Banks, IDC, NEF, required Small Scale Miners to de-risk their Projects and that requires huge financial resources which most Miners Scale Miners 'battle' to acquire hence the initiative by DMRE, CGS, and IDC to Fund Junior Miners through Junior Miners Exploration Fund (JEMF) ease the burden on SCM to de-risk their Projects. However there exist a need to include other rear Earth minerals to broaden the scope and provide 'business friendly' Policies on B-BEE.

The lack of employment could be addressed, and the Country's Gross Domestic Products could be increase and improve the Countries economy to a large extent should partnership between Government and Private Companies encompass all those who participate in mining space.

Such partnerships could alleviate and corruption and address the zama-zamas who are robbing this Country and its Citizens millions of rands which are untaxed and benefit individuals.

Therefore, the call is to have all levels of State and Business working together to improve the socio-economic conditions of those marginalised areas and people living in them.

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