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Geological Society of South Africa

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news

Signs of a renaissance in mantle and early Earth studies in South Africa?

Unlocking South Africa's Geoheritage Potential

Cerussite ($PbCO_3$)

GSSA
Geological Society of South Africa

contents

Front cover photo:
Wits University first-year students exploring the geology of Johannesburg.
See "University News" on pg. 12.

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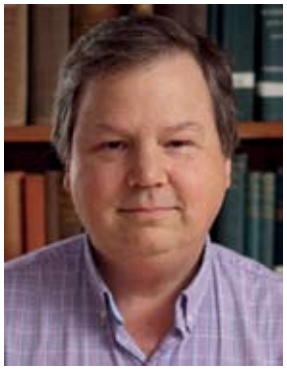
guest editorial

Signs of a renaissance in mantle and early Earth studies in South Africa?



Phil Janney

Axel Hofmann

Due to its world-renowned geology, South Africa has always been the focus of intense interest for those studying the early and deep Earth. Whether it is the remarkable preservation of very ancient sedimentary rocks with traces of microbial life or unique samples of mantle material brought to the surface via kimberlites, South Africa has been a treasure trove for scientific discovery. Of course, the presence of associated superlative economic deposits of gold, diamonds and platinum group metals has only helped to fuel this interest. For the past 120 years, South Africa has had world-class academic, government and industry geologists, but investigations requiring cutting-edge analytical techniques often had to be performed on instrumentation that was not available in this country. This required international scientists to analyse southern African samples at their laboratories mainly located in Europe, North America or Australia, or to send South African researchers and students to these labs overseas to perform their analyses. While such exchanges facilitated collaborations and greater international exposure for South African scientists, it also limited cutting-edge investigations to only those scientific problems of the most obvious scientific or economic impact. In many cases, investigations have been heavily skewed towards scientists from abroad visiting the country for sampling trips with only limited, if any, participation of South African institutions and facilities.

Over the past 20 years there has been slow growth in home-grown analytical capabilities in South Africa, culminating with a burst of new acquisitions over the past few years with the installation of new quadrupole, high-resolution single- and multi-collector ICP-MS and thermal ionisation mass spectrometers and electron beam instruments at several universities, as well as accompanying clean labs, which have greatly facilitated the capacity to measure elemental concentrations, U-Pb ages and radiogenic isotope ratios here in South Africa rather than having to do so overseas. In some instances, this has been supported by traditional channels (e.g., the NRF National Equipment Programme), but in others it has been due to direct investment by government or universities or new funding avenues, such as the research infrastructure platforms of the Department of Science and Innovation (the platform in biogeochemistry, called BIOGRIP, is one of these). These new facilities offer the possibility to perform analyses not previously performed in South Africa (e.g., isotopic analysis of individual diamond inclusions) and to tackle problems requiring much larger geochronological or geochemical datasets than have previously been available, and in the process provide training to a large cohort of young South African Earth scientists. The new facilities will also be used by researchers and students from other African countries, many of whom had previously to rely on facilities elsewhere in the world.

Beside medium-sized, but notable projects, such as those associated with the International Continental Drilling Project, the last truly major international multi-institutional collaboration focusing on the early Earth and development of the southern African lithosphere was the Kaapvaal Project of the late 1990s, which included the Southern African Seismic Experiment, but also had a major component devoted to geochemical and geochronological investigations of the development of Archaean crust and mantle lithosphere in southern Africa. This massive project, involving South African academics (at Wits, RAU (now UJ) and UCT) and industry and government scientists, as well as North American researchers, mainly from the Carnegie Institution for Science and Massachusetts

Group photo at a new excavation at the 890-meter (below surface) level of the Cullinan Diamond Mine.

Institute of Technology, resulted in a tremendous leap forward in our understanding of the structure and evolution of the southern African lithosphere and provided the basis for training a new, but small, cohort of southern African Earth scientists in cutting-edge geophysical and geochemical techniques. Since then, many researchers active in this field have retired and many mines extracting gold, platinum and diamonds that formed in the Earth distant past have closed. However, many interesting questions remain to be answered and many resources remain untapped in the ground.

A recent CIMERA- and GSSA-sponsored Early and Deep Earth research symposium on Archaean cratons and cratonic lithosphere highlighted the current state of knowledge of how the Kaapvaal Craton formed, its evolution since the early Archaean and the development of its mineral deposits. It brought together scientists, industry personnel and students from South Africa for a three-day event, including an excursion to Cullinan Diamond Mine, a 1-day scientific workshop held at the UJ Business School and a field trip to Archaean localities in and around Johannesburg.

Although we have come far in our understanding, there are still major controversies over the origin of cratonic lithosphere and related topics:

- Did cratonic lithosphere form mainly through plume-like mantle upwellings or shallow processes akin to modern plate tectonics?
- What is the timing of cratonisation of the different tectonic domains now forming the Kaapvaal Craton and how exactly is it linked to widespread felsic magmatism (the so called "GMS" series, granodiorite-monzonite-syenite)?
- By what means did sublithospheric diamonds travel from the deep mantle to the shallower regions where they could be entrained by kimberlites?
- What can the Wits Basin and its gold deposits tell us about Kaapvaal cratonisation?

Such controversies will likely require large amounts of new data, and new types of data, to be adequately addressed. The symposium, which also included poster presentations by postgrad students, made it clear that there is strong interest and determination by scientists at all stages to grapple with these questions. Hopefully, organisations like CIMERA will continue to be supported by the DSI-NRF, and the NRF itself will also provide support in this effort.

Some participants of the field trip around Johannesburg.

One hopes that South Africa's scientific legacy in the study of early and deep Earth processes has a brighter future than suggested by the sad state of Johannesburg's mining heritage as displayed at places like George Harrison Park, where cracked display plaques and missing specimens of mining equipment and auriferous Wits conglomerate suggest a severe lack of regard by the local populace. It will be partly up to us in the scientific community to improve our communication to the public the importance of these problems and the value of our research, to ensure that it does.

We are grateful to DSI-NRF Centre of Excellence (CoE) for Integrated Mineral and Energy Resource Analysis (CIMERA) and the GSSA Research, Education and Investment (REI) Fund for funding this workshop. We also thank Anton Wolmarans, Karabo Thuntsi and Theo Phahla of Cullinan Diamond Mine for the opportunity to visit their operation and for leading the mine fieldtrip, as well as colleagues from Wits, UJ and UCT for contributing thought-providing presentations.

Phil Janney and Axel Hofmann

executive manager's corner

Craig Smith

W. Jason Morgan, the originator of the theory of plate tectonics, died on July 31 of this year. An obituary appeared in the October 12 issue of *Nature*, and is a good one-page summary of the development of plate tectonics as a testable theory, which has been accepted by almost all geoscientists around the world. Plate tectonics is the paradigm almost all of our geological thinking is constrained by, and some of us were privileged enough to have experienced its development as students and researchers during the 1960s and 70s. Morgan's contribution was the recognition that the Earth could be divided into a number of rigid plates, as proposed in a 1967 AGU meeting. Plate boundaries could be defined by seismic activity, and with the discovery of magnetic striping in the ocean basins by Fred Vine, acceptance of plate tectonics was unavoidable. Morgan's second key contribution was the plume hypothesis, in which plates moved over fixed mantle plumes to create hotspot tracks. While the majority of Earth scientists accept the theory, it is not universally accepted in its original form, and the more research is done the more discrepancies appear. For example, not all tracks show age progression of eruptive centres. Defining various chemical reservoirs in which plume volcanism originates using isotopic and trace element data has been a key research frontier since the late 1970s until today. Morgan's ideas about plate tectonics and hotspot volcanism are key to the way we understand geology today, in oceanic and continental domains.

Will there be another revolution in the Earth sciences any time soon? That is a hard prediction to make, but new Artificial Intelligence (AI) technology might be a useful tool in the search. There is considerable disagreement over the benefits or otherwise of AI, and there are few if any AI publications in Earth science journals. There are several start-ups developing the technology for application to exploration targeting (three in the US, two in Australia), and some success is being claimed. Any number of universities are actively engaged in researching applications to general earth science, but it is likely that the focus is on climate change. The usefulness of AI to geology needs to be assessed, but the key will be access to large and well-managed data sets (public and private) that can be sampled. We need to master Big Data to be able to test AI.

Members are reminded to check the GSSA meetings schedule for next year, and registration is open for Q1 events, and for the Merensky Reef centenary meeting in August. Abstract submission is open for the 37th International Geological Conference in Busan, Korea, also in August.

It is close to the year-end break, and I wish everyone a safe and happy holiday period. Some good holiday reading is the Haufmann report (Harvard Growth Lab) on the South African economy—and how to fix it. While not focused on the minerals sector, the observations and suggestions are of interest to all.
All the best for 2024.

Craig Smith

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president's column

Te Riu-a-Māui: Earth's Hidden Continent

Steve McCourt

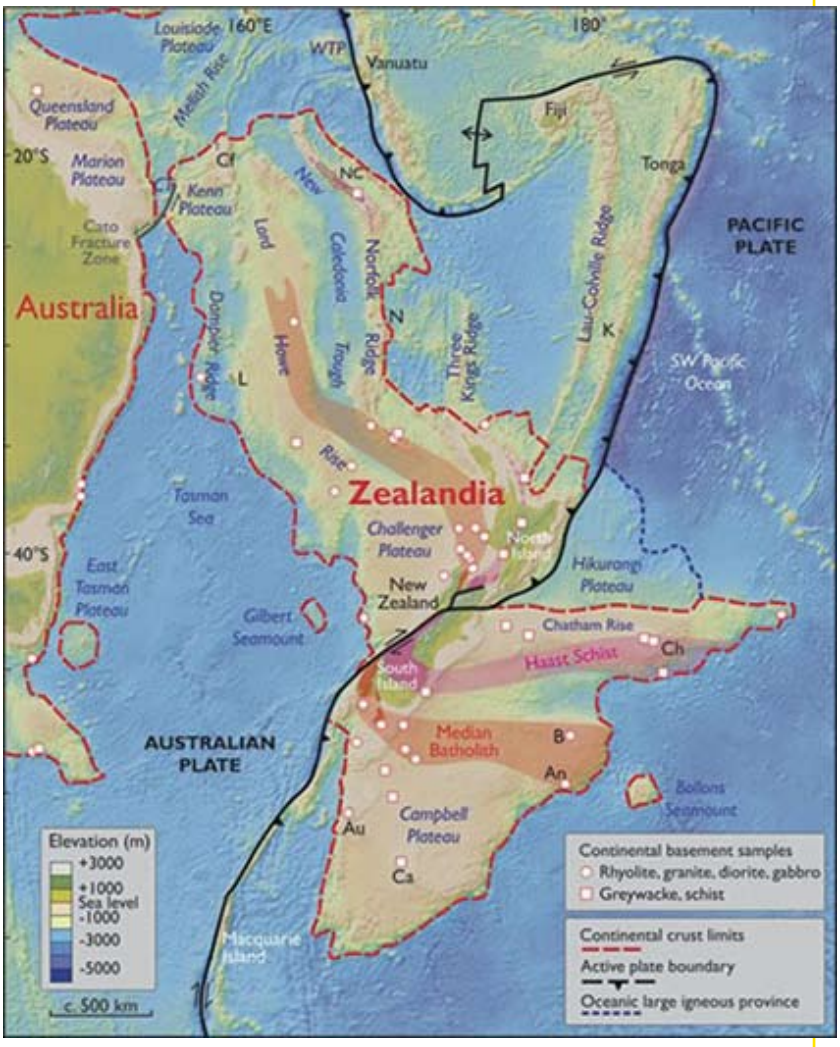
New Zealand is world renowned for being geological active, with high mountains, frequent earthquakes, geothermally active areas and volcanoes. These features are due to New Zealand's position along the southeast boundary of the Australian and the Pacific plates, comprising north- and south-dipping subduction systems connected by the Alpine Fault. In addition, following research led by geoscientists from GNS Sciences, New Zealand is now recognised as the emergent part of the world's 8th continent—Zealandia or Te Riu-a-Māui.

The term Zealandia was first proposed in 1995[1] as a collective name for the islands of New Zealand, the Chatham Rise, Campbell Plateau (areas to the south of New Zealand) and Lord Howe Rise (to the north of New Zealand). Zealandia is about half the size of Australia, but only 5 percent of it is above sea level. The great majority of emergent Zealandia forms the North and South islands of New Zealand, but Stewart Island, just south of the South Island, and many smaller islets are also part of the continent. New Caledonia, a collection of islands lying 2400 km north of Auckland, New Zealand, is the northern tip of Zealandia.

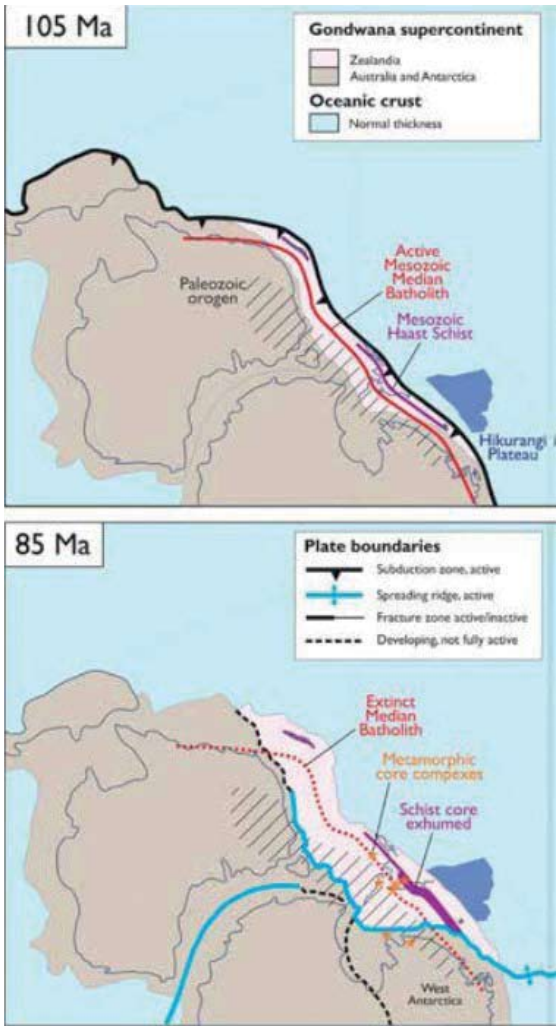
Zealandia has an area of 4.9M km^2, although 94% of this is currently submerged (hence the name Hidden Continent). Zealandia has well-defined geologic and geographic limits and is substantially bigger than any of the fragments of continental crust stranded in ocean basins following supercontinent breakup—~12× the area of Mauritia and ~6× the area of Madagascar.[2] Zealandia is also substantially larger than the area of the largest intra-oceanic large igneous province, the Ontong Java Plateau (1.9M km^2).

The arguments for recognising Zealandia as a coherent continent, rather than a collection

Spatial limits of Zealandia with key features marked.[2]
NC—New Caledonia; WTP—West Torres Plateau; CT—Cato Trough; Cf—Chesterfield Islands; L—Lord Howe Island; N—Norfolk Island; K—Kermadec Islands; Ch—Chatham Islands; B—Bounty Islands; An—Antipodes Islands; Au—Auckland Islands; Ca—Campbell Island. Mercator projection.



of continental islands, fragments, and slices, together with the details of the basement geology of North and South Zealandia, are documented in a series of three papers published over the last six years. In 2017, the Geological Society of America journal *GSA Today* published a paper[2] that showed a region of 4.9M km^2 in the southwest Pacific Ocean was characterised by elevated bathymetry relative to surrounding oceanic crust, diverse and silica-rich rocks (including granite and greywacke), and relatively thick (10—30 km) and low-velocity crustal structure. In 2019 the same group published a more focussed paper in the journal *Tectonics* on the basement geology and tectonics of the 1.5M km^2 South Zealandia.[3] This work tracked granites and lavas across the Campbell Plateau and revealed the thinning and stretching of continent crust as Zealandia pulled away from Gondwana nearly 100 million years ago. The 3rd paper[4] published in October 2023, again in *Tectonics*, focussed on North Zealandia and documented the basement geology and regional tectonics of the area between New Zealand, New Caledonia and Australia.



Zealandia as part of the former Gondwana supercontinent.[2] Upper panel shows Mesozoic orogen convergent margin that was active until ca. 105 Ma. The median batholith is currently exposed on South Island and has been traced across both North and South Zealandia.

Lower panel shows pre-breakup intracontinental extension of Zealandia and West Antarctica from 105 to 85 Ma. Orthographic projections with East Antarctica fixed.

According to Mortimer *et al.*[2], Zealandia is everywhere substantially elevated above the surrounding oceanic crust. The main difference with other continents is that it has much wider and deeper continental shelves. The approximate edge of Zealandia can be placed where the oceanic abyssal plains meet the base of the continental slope, at water depths between 2500 and 4000 m below mean sea level. Data to geologically ground-truth the interpretation of Zealandia as continental crust were obtained by direct sampling of island outcrops, as well as drill core, xenolith, and seabed dredge material. This sampling expedition was supported by accurate and precise geophysical imaging using bathymetry, magnetics and gravity.

The oldest known rocks in Zealandia are Middle Cambrian limestones and 490–505 Ma granites.[2] Although Precambrian rocks have not yet been identified, Rodinian-age detrital zircon grains in Late Cretaceous sandstones suggest they could be present in the basement of Southern Zealandia.[5] Lying above these basement rocks is a drape of at least two dozen spatially separate Late Cretaceous to Holocene sedimentary basins that define the Zealandia Megasequence[6] and include a widespread continental breakup unconformity of ca. 84 Ma age.[7]

The thinnest crust within Zealandia is in the 2200 km-long and 200–300 km-wide New Caledonia Trough, where the water depth varies from 1500 to 3500 m.[2] Seismic profiles across the trough near New Caledonia[8] show ~2–5 km of sedimentary cover over 8.5 km of crustal basement that has a velocity of ~7 km^{-1}. The latter is atypical of oceanic crust, suggesting the New Caledonia Trough is a failed continental rift.[8] The edges of Australia and Zealandia continental crust are within 25 km across the Cato Trough (CT in the figure). The Cato Trough is 3600 m deep, floored by oceanic crust, and the

continent–ocean boundaries on either side are defined by the Cato Fracture Zone, supporting the argument that the Zealandia continental crust is physically separate from that of Australia.[2]

Zealandia was formerly part of Gondwana and was adjacent to West Antarctica along the southeast Gondwana margin[2] and, prior to thinning and breakup, the orogenic belts, Cordilleran batholiths, and normal continental crustal thickness of eastern Australia would have projected along strike into these areas. For most of the Palaeozoic and Mesozoic, the south Gondwana margin experienced episodic subduction-related magmatism and terrane accretion. At ~100 Ma, long-lived subduction ceased and was replaced by a regime of intracontinental rifting and magmatism that resulted in widespread crustal thinning across Zealandia and West Antarctica. By ~85 Ma (Late Cretaceous) South Zealandia had split from West Antarctica and by ~60 Ma (Palaeocene) North Zealandia had split from Australia.[4]

Although it is the last continent to be discovered, following the detailed research carried out by the GNS Sciences team, Zealandia is the first continent to have its geology fully mapped out to its submerged edges.

Steve McCourt

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professional affairs

THE PROFESSIONAL (AFFAIRS) CORNER

November saw SACNASP celebrating their 20th anniversary. As part of their celebrations, they presented the GSSA with a recognition award for our contribution towards the Candidate Mentoring Phase (CMP) programme.

The SACNASP programme is run with Voluntary Associations like the GSSA. It provides prospective professional scientists with a mentor who will help them advance from candidate to professional status, provide them with the skills they need to perform to their fullest capacity and empower them to set and achieve goals for their professional and personal development. SACNASP and the GSSA have been partners in the mentorship programme since 2020 and 45 young geoscientists have been mentored and given access to GSSA events, coaching sessions and networking opportunities.

Noleen Pauls

all the news fit to print

University of the Witwatersrand

Congratulations to Prof. **Lew Ashwal** on being named winner of the Vice-Chancellor's Research Award at the Annual Council/Senate and VC's Awards Dinner on the 31st of October. The award is well deserved, as it recognises a Wits scholar who consistently demonstrates research excellence and Lew has certainly done this time and time again.

Another outstanding achievement is the publication of Dr. **Karen Smit's** work in *Nature*. The paper titled "Sublithospheric diamond ages and the supercontinent cycle" features Karen as a coauthor for performing the isotopic analyses on the diamonds while still based at Carnegie.

The School would also like to welcome **Robyn Symons** and Dr **Leonidas Vonopartis** who have

Prof. Ashwal (seated) pictured with other winners on the evening.

Dr Smit photographed for an interview in Engineering News.

both joined the School recently. Leonidas joins us as the new economic geology lecturer, and Robyn as the collections curator and geocommunications manager.

The second semester typically means a lot of fieldtrip activity, and this year was no exception. The first-year students got their first taste of the geology around Johannesburg, while the third-year students and geophysics field school participants spent 9 days down in Vredefort.

The South African SEG Student Chapter (SAS-SEG) also organised a visit, led by Prof. Bertus Smith, to the Iron and Manganese ore deposits of the Northern Cape. The trip began with a hike to the top of Kuruman Hill, which allowed the participants to observe evidence of the Great Oxidation Event. The group also visited Kathu near the Sishen Iron ore mine as well as Hotazel to look at drill core at South 32's core yard, mostly comprising banded ironstones with 3 prominent ore horizons. Later they also travelled to ASSMANG's Black Rock Mine,

Field tripping: First-year students exploring the geology of Johannesburg.

Field tripping: Third-year students mapping in Vredefort and the geophysics field school participants who later joined them.

where the only outcrop of the Hotazel Formation in the Kalahari Manganese Field is exposed and where the old historical mine workings are still visible.

Ending the year off on a high, the SAS-SEG committee for 2023 consisting of David Russo (President), Casper Karadzandima (Vice President), Thabile Seerane (Treasurer) and Mabatho Mapiloko (Secretary), closed out their term at the annual Geoquiz in late October, which is always a hit.

*Compiled by **Sarah Glynn** from various contributors within the School*

Group photo of the SAS-SEG members at the summit of Kuruman Hill. The outcrop in the background is of the Palaeoproterozoic Kuruman Iron Formation of the Asbestos Hills Subgroup, which overlies the Neoarchaean stromatolitic dolostones and limestones of the Campbellrand Subgroup.

branch & division news

Northern Cape Branch

Kalahari Manganese Fields Event and Excursion
In remembrance of Prof. Nic Beukes
Kuruman, NC, 9th & 10th November 2023

"Every memory we create is a footprint on the path of a life we make together."

Special thank you to Assmang, South 32 and Glosam mines for hosting us and to the speakers for their exciting talks—Prof. Bruce Cairncross, Prof. Bertus Smith, Dr Bjorn Von Der Heyden and Thomas Rambuda—the diversity of interesting talks was well incorporated and fitting for the memorial of Prof. Nic Beukes.

Thanks also to Benjamin Ruzive/Lawrence Ngalela (Black Rock), Leonita Kuhn (Mamatwan), Elmar Human (Glosam) and Nkosinathi Mthethwa (Glosam) for hosting the mine site visits. To all who attended, thank you for sharing the event with us—what an amazing time with you all!

Thank you to our sponsors, your contribution was greatly appreciated.

Loni Gallant
NC Branch Chairperson

New committee members

Executive Committee:

- Chairperson: Loni Gallant (Lisani Geological Services)
- Vice Chairperson: Palesa Boikanyo (South 32)
- Treasurer: Francois Stassen (Imdex Limited)
- Secretary: Tricia Scott (Anglo American)
- Communications: Thabang Phakoe (DMT Kaibatla)

Additional Members:

- Elmar Human (Minrom)
- Conrad de Kock (Raubex)
- Eveline Kekana (Assmang Khumani Mine)
- Kabelo Mongalo (Alexkor)
- Leonita Kühn (South 32)
- Lutendo Mavhungu (RES)
- Lorena Tafur (Anglo American)
- Nkosinathi Mthethwa (Glosam Manganese Mine)
- Vince Schaper (Maxgeo)


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the geological hot pot

As I am busy writing up this column (13 November 2023), the evacuation of the town of Grindavik in southwestern Iceland on the Reykjanes Peninsula has made global headlines. This is because Icelandic volcanologists have issued a warning that an eruption is imminent. In addition, the government has initiated the building of protective walls around the nearby Svartsengi hydrothermal power plant to divert any potential lavas flows. By the time you read this, the predicted eruption may or may not have occurred. Nevertheless, an eruption at the Fagradalsfjall volcano on the same trend occurred between the 21st of March and the 6th of May 2021. This enabled the Icelandic geoscientists to collect samples of the volcanic lavas as they erupted and study their geochemistry as they evolved over time. They found that the earliest basaltic lavas came from shallow levels in the mantle, but this changed rapidly over the time period in question. The later basalts came from deeper levels in the mantle. The research findings were published in September last year and reported in *SciTech Daily*. The *Nature* article is available on Open Access. No doubt the same group of volcanologists have issued the evacuation warning, and one can only hope that there is no loss of life if the eruption does occur.

That volcanic eruptions will always be a threat is reflected in the amount of research conducted globally on them. As we know, Japan is situated on the Pacific Ring of Fire, and being able to predict volcanic eruptions is one of the country's priority research topics. One group of Japanese scientists has sampled fumarolic gases to monitor magmatic-hydrothermal systems by measuring the carbon isotope compositions, and the types of noble gases in them. They found that the $^{3}He/^{40}Ar$ ratio changes

The Blue Lagoon, a tourist attraction near the town of Grindavik in Iceland. (Photo: K. Luk)

with the amount of degassing that takes place in the magma, and hence indicates potential eruptions. The Open Access article is published in *Nature*, and the popular account is available in *SciTech Daily*.

To round off the theme on volcanoes, a geoscientific team from the University of Geneva has published their recent research results, as reported in *SciTech Daily*. They assessed the likelihood of a volcanic eruption to occur by collecting a lot of geophysical and geochemical data about them, and then concluded that three parameters were key: a volcano's elevation, the depth of the rock layer that separates the magma chamber from the surface, and the magma's average chemical makeup. Satellite radar imagery was used to determine the heights of the volcanoes studied, seismics and volcanic mineral chemistry were used to measure the depth to the magma chamber below the volcanoes, and direct sampling of lavas gave the average chemical composition of the magma involved.

"Diamonds are forever" must be one of the best and most successful advertising slogans ever. Think of the billions of dollars that have flowed into the coffers of the countries that have been blessed with diamond deposits. Marilyn Monroe singing "Diamonds are a girl's best friend" in the movie "Gentlemen Prefer Blondes" certainly contributed in no small measure to the allure of diamonds. It is thus not surprising that research on diamonds and their host rocks is still important, not only in commercial terms, but also to understand the deep workings of our planet. Three articles that I've come across deal with aspects of the origin of diamonds. The first reports on the use of supercomputers in Canberra, Australia, to create three-dimensional geodynamic models of the Earths' mantle. The geoscientists calculated the movement of heat upwards from the core and found that this can be achieved by broad mantle upwellings or "pillars of heat", commonly termed mantle plumes. They also found that many kimberlites lie directly above these pillars, implying that the pillars supplied the heat that generated the kimberlite. More details of the study can be found in *The Conversation*.

The second article reports on the study of a diamond from Botswana that came from 660 km below the surface of the Earth. This depth is inferred by the presence of ringwoodite inclusions, a very high-pressure mineral, and a few that are also hydrous. The inclusion assemblage provides evidence that the transition between the upper and lower mantle

Diamonds from the marine workings near Kleinsee in the Northern Cape Province.

The famous Big Hole in Kimberley.

(around 660 km depth) is a water-rich environment. This finding is important because water is an important component in many of the Earth's geological processes, especially what is known as the deep-water cycle. This involves the "sucking down" of water into the mantle via subduction, and the "spewing out" of water during volcanism. More on this can be found in *ScienceAlert*.

We know diamonds crystallise deep in the mantle and are carried up to the Earths' surface as passengers in kimberlitic magma. But the details of how and where this occurs have not been fully resolved. A recent study using artificial intelligence (AI) has, however, come up with a plausible theory that has significant implications for diamond exploration. The geoscientists hypothesise that there is a link between continental breakup and the occurrence of kimberlite. They found that kimberlites erupt about 20 to 30 million years after a (super)continent breaks up. In addition, the eruptions migrate with time towards the interiors of the newly separated continents at a uniform rate, away from the edges. A readable account of the findings is given in *The Conversation*.

Cycads are fascinating plants that originated way back in the Mesozoic era and were one of the favourite foods of grazing dinosaurs. Not the snack of choice for T. Rex! South Africa has at least 22 species of the plant, many of which are endemic and rare, and consequently of high monetary value to collectors. An unfortunate result of the latter is the illegal poaching of wild specimens. From the great variety of cycads that evolved in the heyday of the dinosaurs, only a few survived after the Chicxulub meteorite impact event that was mostly responsible for the demise of the animals. Geoscientists have now found out how the cycads that survived the extinction event did so. It turns out that the present-day cycads use bacteria in a symbiotic relationship to fix atmospheric nitrogen to promote growth. In contrast, the fossil cycad species studied were not nitrogen-fixers. Just why and how being able to fix nitrogen helped the cycads to survive is not clear, the possibilities being better adaptation to fluctuating climate after the impact, and/or better competition with angiosperm plants that rapidly evolved during the Tertiary era. More details of the study can be found in *SciTech Daily*.

One of two cycad plants at the Council for Scientific and Industrial Research offices in Carlow Road, Johannesburg.

What group of land animals weighs more than all the humans on Earth (all eight billion of us) together with all of our domestic livestock (numbering in the billions)? Answer: the invertebrate arthropods (insects, caterpillars, spiders, termites, ants, lice etc.). This surprising fact (at least to me) is the conclusion of a group of researchers in Germany, as

Colourful locusts near Kenhardt in the Northern Cape Province.

Phalaborwa copper mine in 1981. The open pit has stopped operations, and underground mining is taking place.

reported here. Of the total biomass of arthropods in soil, termites and ants comprise 40% and 10% respectively. Although the total biomass above ground has been difficult to quantify, the researchers nevertheless estimate that the total biomass of all the arthropods is around 300 million metric tonnes (Mt), just over the total mass of all human and their domesticated animals. The research, available from *ScienceAlert*, furthers knowledge on arthropod abundances and the impact of humans on their ecological environments.

We as laypersons in general, and geoscientists in particular, are always aware of the importance of the rare earth elements (REEs) in our everyday modern lives. We also know that China is the dominant player in the REE field, and hence the collective global effort to lessen this dependence, as it is perceived as a major threat to the future of a renewable energy economy. This is discussed in an interesting article, available here, on the Mountain Pass REE deposit in the USA. The article also outlines the sources of REEs over time, and the complicated chemical processes that the ores undergo to separate out the different elements. Closer to home, a company named Rainbow Rare Earths has received US$50 Million to pursue its REE project at Phalaborwa. This amazing intrusion has been mined for over 67 years for copper, in addition to apatite (used in the production of fertiliser) and vermiculite. The magnetite that was separated from the copper ore and stockpiled, has found a market and is being shipped out.

I was always interested in arithmetic and mathematics at school, which made me a bit of a nerd. For my sins, I managed a distinction in Matric mathematics, which helped me get into a BSc programme at Wits. Although I majored in geology and chemistry, I had to do a second-year course in mathematics for the chemistry part of the degree. I passed this at the second attempt, learning just how difficult higher mathematics is, but have not lost my interest in the subject. So when I saw this article in *Scientific American* about the most boring number in the world, available here, my eyes lit up, and I hope you find it a good read too. It turns out that numbers can be divided into two camps: exciting values and boring ones. Hope this article does not put you to sleep!

George Henry

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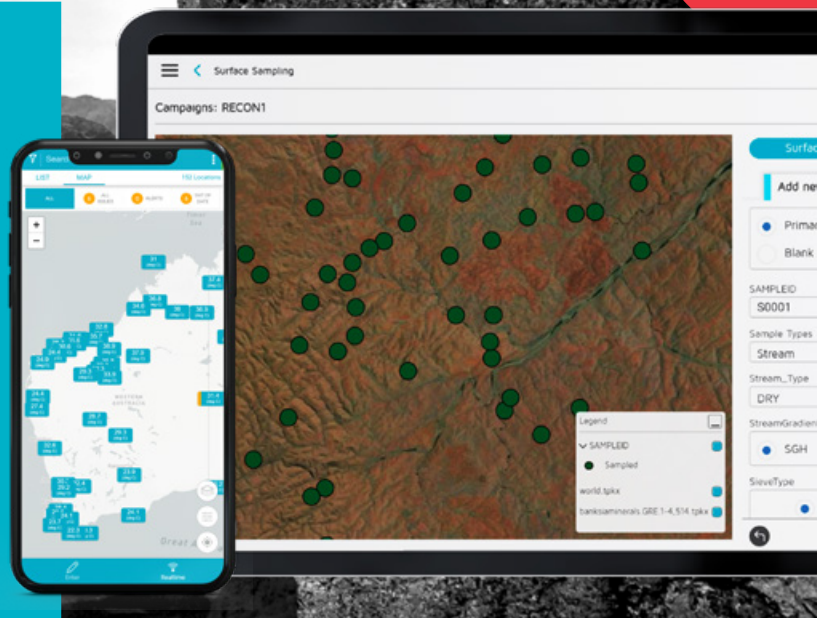

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Unlocking South Africa's Geoheritage Potential

Introduction

South Africa's geological endowment transcends the mineral resources industry. From the country's favourable global location, its geological architecture, stratigraphy, and geomorphic landscape, multiple industries have been born over the millennia of human settlement in the region.[1] While it is recognised that there is a multiplicity of geological resources in South Africa (and southern Africa), which could create numerous GeoHeritage, GeoEducation, and GeoTourism opportunities, the country has yet to unlock the full potential of this immense wealth and the diversity of these possibilities. In South Africa there are two UNESCO accredited geological GeoHeritage sites, compared to more than 41 UNESCO sites in China, for example. South Africa is losing out on financial benefits and many economic, educational, tourism and social upliftment opportunities and drivers that GeoHeritage, GeoEducation and GeoTourism provide in many other countries around the world. The Overberg Geoscientists Group (OGG), through its efforts in the southern Cape and more widely, has embarked on a series of integrated activities and interventions, including within GeoEducation, GeoHeritage and GeoTourism, to increase awareness of South Africa's remarkable geological and mineral endowment. OGG programmes focus on the importance of geology, minerals, soils and water as the basis for daily life, including food supplies, transport, infrastructure, education and medical facilities, water sources and ongoing human development.

The construction of the 4.6 billion-year Earth-Age and 550 million-year Local Geology displays at the Gansbaai African Penguin & Sea Bird Sanctuary (APSS) and Harold Porter Gardens (HPG) at Betty's Bay in the Southern Cape by the OGG are highlighted below. These OGG interventions and activities, and potential economic and related benefits that should flow from the country's exceptional geological resources and endowment are addressed in this article.

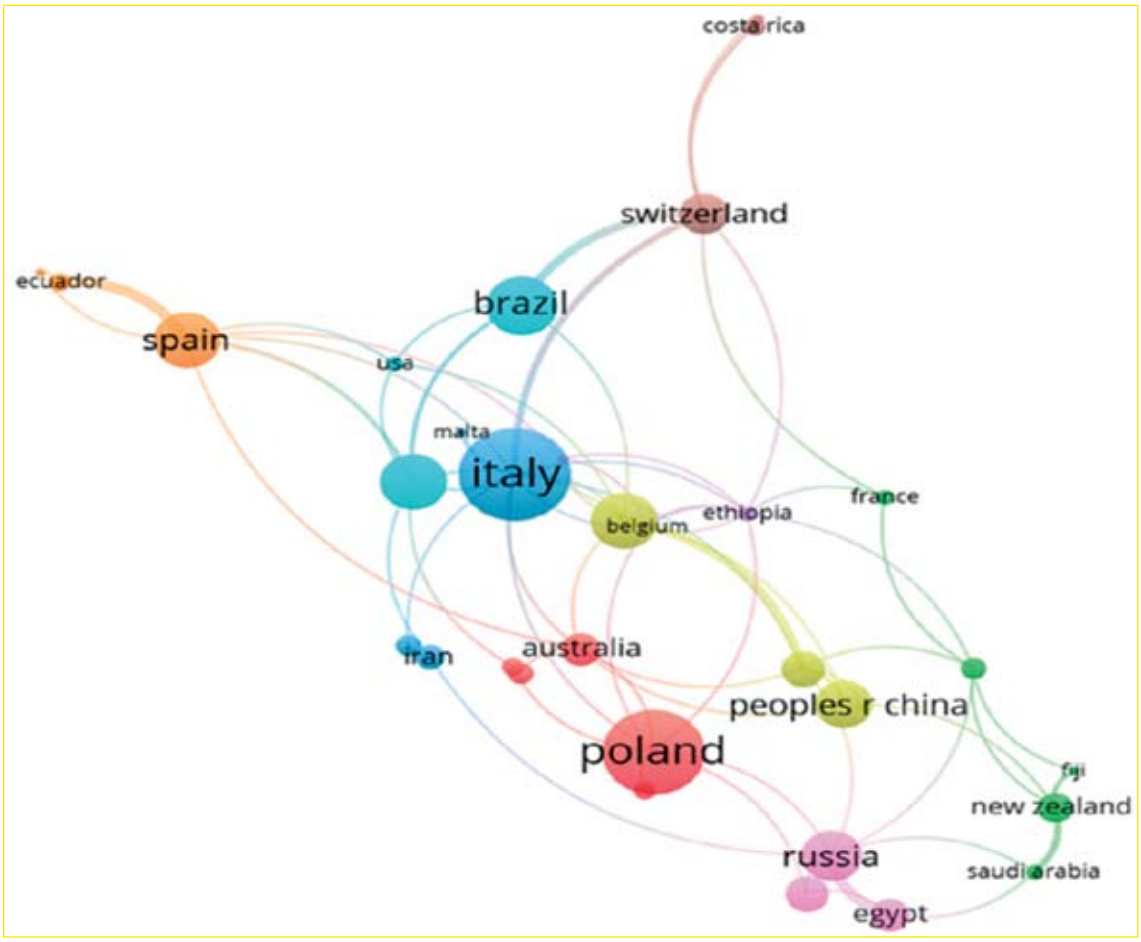
In spite of the treasure trove of GeoHeritage and related opportunities in RSA, as well as many meetings, proposals, documents, conferences and efforts to promote GeoHeritage by key champions trying to address this situation, the lack of a cohesive plan, leadership, and adequate resources are all serious stumbling blocks.

Background

GeoTourism, GeoHeritage and GeoEducation are all closely inter-related, and if documented and properly developed and utilised, can sustain and enhance the identity and benefits of a territory, by taking into consideration the territory's geology, environment, culture, aesthetics, heritage and the well-being of its local surrounding residents.[32] GeoTourism relates to the territorial identity of an area, and the United Nations Educational, Scientific and Cultural Organisation (UNESCO) Global Geoparks (UGGp) are recognised as an important driver for GeoTourism development.[2-5]

Geoparks are "single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development".[33] Though GeoTourism and UGGps are not exclusively linked to one another, they are increasingly considered to be drivers of strategic territorial development plans underlying Sustainable Development Goals (SDGs).[6]

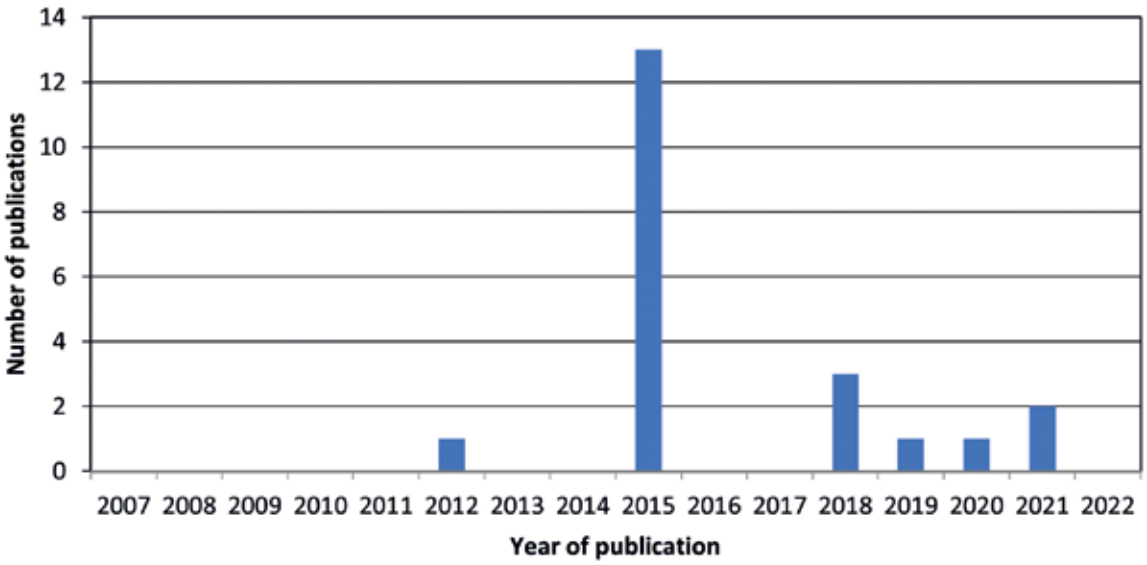
In recent decades, GeoTourism, and underlying GeoHeritage and GeoEducation, have experienced



Network visualisation showing the frequency in number of GeoConservation, GeoTourism and GeoHeritage studies in countries around the world.[7]

growth around the world and will continue to be prominent in the future.[7] Studies of the number of published journal articles on GeoTourism between 2012 and 2014 per region indicate that GeoTourism research is concentrated in Europe (mainly in Italy and Poland), Asia (mainly in China and Iran), and South America (mainly in Brazil).[8] GeoHeritage, GeoTourism, and Geoparks research is rapidly expanding in the Global North,[7,8] whereas the Global South and South Africa are way behind.[9]

In 2018, the largest share of GeoTourism research was conducted in Europe, with only a total of 19 studies conducted in Africa.[10] GeoTourism is also well established in Australia[18] and New Zealand, which in 2022 posted the *New Zealand Geopreservation Inventory* on the New Zealand Geological Society Website showing the locations and mapped extent of 3 200 outstanding geological sites and landforms throughout the country.[11]



Number of studies related to GeoTourism governance in Africa published from 2007 to 2022.[9]

Definitions of GeoHeritage and related facets

GeoHeritage: The following parameters are the most commonly accepted components and definitions of GeoHeritage, based on wide-ranging research and interaction with laypersons, scholars, communities, and the general populace (as well as geologists, and other technocrats):[1,12]

(i) Taking geology to the people, such that they are able to gain a better and informed appreciation of the many related facets of geology, minerals and water that are key to the sustainability of all life forms found on Earth, and develop an understanding of Earth history and the many attributes and benefits of geology, geomorphology, soils, rocks, minerals and mining, and that by doing so we also create/propagate the young geoscientists of the future;

(ii) Serving the ***public interest*** by providing resources, linkages, information, education and knowledge of sites (local or regional) that advance our knowledge of geology, Earth processes, natural hazards, ground water supply, soil processes, climate and environmental processes, evolution of life and extinctions, our essential mineral and energy supplies, and other aspects of the nature and history of the Earth;

(iii) Ensuring that the positive legacies and contributions of geologists and their profession to society in general are recognised and acknowledged.

GeoTourism: Activities of many shapes and forms that sustain and enhance the geological, geomorphological, and geographical character of a place, its environment, culture, aesthetics, heritage, and the well-being of its residents and communities.[2,3,13]

GeoEducation: The provision of interpretative services, facilities, information, and practical interventions (e.g., simple informative signage or QR codes to avoid vandalism) to enable citizens, communities, scholars, and tourists to acquire knowledge and understanding of the geology, geomorphology, and related environmental aspects of a site, area or region, and thereby an overall appreciation of the role that Earth history, and geology, rocks, minerals, soils and mining contribute to practically every facet of daily life.[14]

The concept of *GeoEducation* is used in relation to both informal education and formal education (schools and universities). Informal and formal outdoor learning or field education is the most effective form of interpretation and promotion of GeoHeritage.

GeoTourism, GeoHeritage and GeoEducation in South Africa

Work done by Matshusa[2] in the northern part of Kruger National Park (KNP) provides an excellent example and basis for far-reaching and broader GeoHeritage initiatives across South and southern Africa. The KNP has many exceptional opportunities for developing sustainable GeoHeritage, GeoTourism and GeoEducational trails, interventions, opportunities, and related job creation among adjacent communities. Importantly, this work highlights the importance of wider job creation, education and skills transfer into communities and disadvantaged youth and learners adjacent to the KNP.

As is the case across many parts of southern Africa and further north, the geology and rocks of the KNP,[15,28-30] played a key role in shaping the culture of the local people.[2] Research in the 1980s showed that early inhabitants from the northern part of the KNP used local rocks to manufacture weapons for hunting or battle, and iron-ores from melted rocks for tools for agriculture, mining and ornaments.[15] Early inhabitants of the KNP and surrounding areas were most astute in terms of utilising the different soils to graze animals and plant crops for food supplies. More than 300 archaeological sites of Stone Age man have been found in the KNP and there are significant archaeological ruins at Thulamela and Masorini.[2] As regards untapped GeoTourism potential, for the Venda communities abutting the northern part of the KNP, there

are exemplary GeoHeritage sites with high GeoEducation, GeoTourism, and cultural value that are currently totally unutilised.

Overarching research undertaken on South Africa's GeoTourism potential by Banzi Geotechnics[1] and the work done on this topic in the northern KNP[2,16] have highlighted the many benefits (economic, employment, skills transfer and others) of GeoTourism. As of November 2023, the UNESCO Global Geoparks Network (UGGN) comprises 195 global Geoparks in 48 countries and territories, with only two in Africa (M'Goun Global Geopark in Morocco and Ngorongoro Lengai in Tanzania) and none in southern Africa.

The European Geoparks Network (EGN) is the single largest Global Geoparks Network, with 94 UGGps from 28 European countries out of 195 UGGps, followed by the Asia Pacific Geoparks Network with 76 UGGps. International studies and the development of GeoTourism in China,[17] with its 41 UNESCO accredited Geoparks, and Australia[18] show that proper development of GeoTourism activities provides considerable opportunities for local and international tourism, education, as well as benefitting local businesses and communities.

To unlock this potential, it will be important to develop an inventory of products and foster a willingness and cooperation among different role players, including researchers, national departments, management entities, academics, statisticians and local communities. GeoTourism offers an entire new market segment to broaden business, employment and experiential opportunities in the KNP and assist in alleviating poverty, especially in adjacent rural areas. Furthermore, GeoEducation contributes to SDGs.[4]

Governance of GeoTourism and related activities in South Africa

South Africa is mainly governed by the *National Heritage Resources Act*, Act No. 25 of 1999 (NHRA). Among the other important acts and regulations are the Cultural Institutions Act of 1998, the World Heritage Convention Act of 1999, and the Minerals and Petroleum Resources Development Act (MPDRA).[2] Provincial laws and ordinances and local by-laws also add to the regulatory regime of these heritage resources at provincial and local levels.[2,9] The NHRA does not explicitly define GeoTourism; however, Section 3 identifies geological sites (GeoHeritage sites) of scientific and cultural importance as a national estate. One of the objectives of the NHRA is to nurture and conserve heritage resources for the benefit of current and future generations. However, the National Department of Science and Technology (NDST) indicates that an enduring legacy of the apartheid era is that the richness of South Africa's fossil and archaeological heritage is not matched by a corresponding public passion and appreciation.[19]

Although the strategic and legislative framework for protecting South Africa's heritage resources has been in operation for more than a decade, it has neither achieved the desired level of heritage management and protection nor the adequate development of the heritage sector.[19] Moreover, while legislation exists in South Africa to pursue and implement the protection of geological sites, a lack of manpower and funding presents persistent problems.[20-24] GeoTourism in South Africa has not been effectively developed and promoted by the NDT and many other organisations that should be doing so.

Reasons for this include a lack of institutional and public participation in geology,[20] lack of data on important geological or geomorphological sites,[29] the conflation of geological with other ecological and cultural heritage issues[20] and problems with relevant legislation and management.[24-26] The National Environmental Management and Protected Areas Act, Act No. 57 (NEM: PAA) of 2003 mandates Conservation and Game Parks (e.g. South African National Parks or SANParks) to create destinations for nature-based tourism in a manner that is not harmful to the environment. The reality is that NHRA and NEM: PAA are not being fully implemented, and hence GeoHeritage

and GeoTourism and related opportunities for community upliftment, job creation, and education are not being realised. Recent studies[9] have proposed an inclusive and integrated governance model to develop GeoTourism and GeoHeritage sites in South Africa.

OGG Harold Porter Gardens Earth-Age displays—South African National Biodiversity Institute (SANBI) partnership

The OGG has, in partnership with other educational organisations, successfully launched two highly informative HPG *4.6 billion-year Earth-Age* and *550 million-year Local Geology* displays in the Overstrand (Southern Cape). These are a key part of its GeoEducation initiative to expose laypersons, policymakers, students, scholars and the youth to the major events that led to the formation of the Earth and unlock the unrealised GeoHeritage and GeoTourism potential of South Africa. The Earth-Age Display (EAD) highlights the Earth's initial 'Big Bang' formation event, subsequent evolution, the appearance of oxygen and water, plate-tectonic events, the formation of early life, major extinctions, appearance of our predecessors and modern humans, natural climate change, and the importance of preserving scare resources.

The displays and durable artwork boards depicting the sequence of geological events that the Earth has experienced from 4.6 billion years till the present day each contain simple diagrams, user-friendly text, sponsor details and QR codes. These codes allow interested parties to drill-down into the OGG website section pertaining to the HPG display and obtain additional technical information related to each Earth-forming event and access references to additional information.

The construction and development of these displays has been based on extensive local and international research on GeoEducation, GeoHeritage and GeoTourism interventions in South Africa, other African countries, the UK, USA, Australia, Russia, Europe, China and related literature searches. A key consideration was that they should be robust, durable and outdoor-based with no need for expensive building and structures requiring costly

Activities during the construction of the 4.6 billion-year Harold Porter Gardens Earth-Age Display and Rock Garden during 2023. The displays are located at the northern end of the gardens with the Table Mountain Group rocks of the Kogelberg Mountains in the background.

long-term maintenance, repairs and personnel. They should also be located in existing natural environment sites where they add value to existing geological and related natural environment settings, and in a setting of overall security and safety.

David Mourant (an experienced geologist and resident of Betty's Bay, Western Cape), who was involved in the establishment of the famous Barberton Makhonjwa Geotrail, a UNESCO World Heritage Site situated on some of the oldest (+3.5 billion years) and best-preserved rock sequences on Earth, and Jean Malan (Kleinmond) were the key drivers of this educational initiative. Tremendous support and teamwork was provided by the South African National Biodiversity Institute (SANBI) Team at Harold Porter Gardens, led by Linnette Ferreira, Lorreta Floors, Wonga Komanisi and the HPG management team.

The launch of the HPG EAD and extended display of the local 550 million-year geological history of the Southern Cape region took place on Friday 15 September 2023. It was attended by about 115 participants in foul weather. The participants included SANBI personnel from Pretoria, Kirstenbosch, the Karoo and Harold Porter Gardens, the OGG, local Botanical Society members, zoologists, hydrogeologists, the Overstrand Municipality Tourist Department, and other interested laypersons, educators, and interns from the SANBI/HPG Educational Department.

Also in attendance at the launch on 15 September was Jane Forrester, whose foresight and 36-year career at SANBI (27 years at HPG) led to the construction of the original displays showing the relationship between local geology formations, soils and plant types. These previously constructed displays now merge with the new EAD and Local Geology displays to collectively highlight the remarkable 4.6 billion-year history of planet Earth, including subsequent soil and related plant formation.

Gansbaai Earth-Age Display—African Penguin & Sea Bird Sanctuary (APSS)/Dyer Island Trust partnership

The geological and related displays in HPG emulate the Gansbaai *Earth-Age Display* and linked *Rock-Garden Display* that highlights the 550 million years of Overberg geology, constructed in 2020. This equally informative educational Gansbaai facility was funded through the generous support of the Dyer Island Trust.

Mike Dormer, a key OGG member based in Gansbaai, provided the planning and engagement with local conservation groups, schools and educators to ensure this well-used facility was successfully completed. The use of these educational facilities and interaction between OGG team members, schools, laypersons, tourists and other interested parties is growing steadily.

Sponsorship and financial support for OGG activities

The HPG and APSS Earth-Age and Rock-Garden Displays have been funded collectively by OGG member contributions, the 35th International Geological Congress Legacy Fund (35IGC LF), South African National Biodiversity Institute (SANBI), Kogelberg Botanical Society, donations from the International Hydrogeology Group facilitated by John Weaver, Minrom Consulting (Somerset West), the Dyer Island Trust and some local residents.

Importantly, these OGG initiatives described have focussed on benefiting communities and businesses from local towns, use of local artisans and involvement of parents and scholars from local schools. At HPG all the key workmanship and construction was undertaken by the local HPG team, an excellent small building group from the Kleinmond community and a steel manufacturing entity from Bot River. Likewise, the APSS EAD and local geology displays were undertaken by staff of the APSS and all materials were purchased locally in Gansbaai.

The OGG activities and programmes are leveraging the informative, practical, cost-effective GeoEducational sites at HPG and the APSS in the Overberg, the wealth of other spectacular geology, geomorphology, rock and soil types all

The OGG Team and Sponsors involved in the construction of the Harold Porter Gardens Earth-Age and Local Geology displays at the launch of the displays on 15 September 2023. Mike Dormer, Mike De Wit, Oscar Van Antwerpen (Minrom), Kathy Blaine, John Blaine, Marilyn Bristow, Prof. Izak Rust (retired Honorary Member), Jean Malan, Anne Mourant, David Mourant, John Bristow, Richard Mourant.

exposed in gorgeous 3-D, exceptional aquifers, and world-class anthropological sites (e.g. Die Kelders Caves[27] on the Southern Cape coastline) to unlock the GeoHeritage potential of the region. Regular organised field excursions, educational presentations to school learners and groups (e.g. local botanical societies, University of the 3rd Age [U3A] groups), and morning and afternoon visits to the HPG and APSS educational facilities are gaining ground, as well as visits by other organisations, individuals and tourists.

Recently (15 November 2023), an afternoon excursion led by OGG members to the Harold Porter Gardens, including explanations of the EAD and linked geological displays, Disa Kloof Waterfall and surrounds, attracted 36 participants of mostly non-geologists, young SANBI Education Department Interns, and local Overstrand Municipality Tourism Department Trainees.

GeoHeritage sites (or GeoSites)

GeoHeritage sites serve the public interest and are critical to advancing knowledge about the geological history and evolution of the Earth, natural hazards, groundwater supply, soil processes, climate and environmental changes, evolution of life, mineral attributes and energy supplies. Such sites have high potential for use as outdoor classrooms, GeoTourism, and scientific research, thereby enhancing public understanding of geoscience and other sciences, recreational use, and economic support to local communities. *GeoHeritage Sites* can be:

(i) ***Small but scientifically and aesthetically significant sites,*** such as a road cuts, or named and managed sites of a few acres such as ancient mining and smelting sites (e.g. Palaborwa), key mineral discovery sites (e.g. diamonds at De Kalk on the banks of the Orange River), unique exposures of ancient rocks (e.g. spinifex in the Barberton Mountain Land), exposures in old mine sites (e.g. the original Witwatersrand Langlaagte site) and active mine sites;

(ii) ***Extensive areas with local and international recognition,*** such as the Kwathlamba Mountains (Drakensberg), Table Mountain (Cape Town), Kruger National Park, Grand Canyon (Arizona, USA), and Yellowstone National Park (Wyoming, USA);

(iii) ***Artificially created ('man-made')*** educational and historical structures and sites (e.g. museums, rock gardens, botanical gardens, and similar facilities), which provide laypersons, scholars, communities, disadvantaged citizens, researchers, and 'experts' with opportunities to observe the relationship between geology, soils, flora and fauna, and the environment; e.g, Kirstenbosch Botanical Gardens, Babylonstoren Historical Farm + Gardens (between Franschhoek and Klapmuts in the Western Cape), Harold Porter Gardens (SANBI), Walter Sisulu National Botanical Gardens (SANBI), Barberton Makhonjwa Geotrail, the famous Bakerville Diamond Diggings north of Lichtenberg, the Kruger National Park and environs with its many exceptional GeoHeritage sites[28-30] and numerous others.[9,21,27,31]

GeoHeritage sites may be on privately owned land, on land in public ownership ranging from municipalities to the central (federal) government, or on land of mixed ownership. Large or small, and regardless of ownership, many are vulnerable to urbanisation, infrastructure development, agriculture, over-use, or erosion. Conservation strategies appropriate to the type of site and nature of ownership are important to protect GeoHeritage sites from loss and maintain them for the long-term public interest.

Conclusions

It is common cause that the geological and mineral endowment of South Africa is exceptional by world standards, and deposits such as the Witwatersrand Gold Basin, Bushveld Igneous Complex and Vredefort Impact Structure are unmatched anywhere else on the globe. Historical 'discovery sites' and exceptional geological features within the confines of these ore-bodies should be preserved for prosperity, and as educational and teaching localities.

The experience, building-blocks, and legal framework are in place in South Africa to promote GeoEducation, GeoHeritage, and GeoTourism.[3] To unlock this potential, it will be important to develop an inventory of products, and foster a willingness and cooperation among different role players, including researchers, national departments, management entities, academics, statisticians and local communities. Drawing on international guidelines and precedents will also be important.[32-35]

Unfortunately, the benefits, development, and distribution of the past wealth derived from South Africa's exceptional geology and mineral resources has been unequally shared among the population. However, considerable economic, social, and educational benefits remain to be unlocked from this endowment.[2-5,9,16]

GeoTourism offers an entire new market segment to broaden business, employment and experiential opportunities across South Africa to assist in alleviating poverty, especially in adjacent rural areas.

In spite of the treasure trove of GeoHeritage and related opportunities in RSA, as well as many meetings, proposals, documents, conferences and efforts to promote GeoHeritage by the local champions[1,2,20,21] trying to address this situation, the lack of a cohesive plan, leadership, and adequate resources are serious stumbling blocks.

Organisations such as the Council for Geoscience (CGS), Geological Society of South Africa (GSSA), and the South African Institute of Mining and Metallurgy (SAIMM) should be playing a far greater and more proactive role to unlock the GeoHeritage potential of RSA and thereby educate citizens and communities about the many benefits of exploration and mining and unlock much needed economic development and job creation in the process.

John Bristow, Khodani Matshusa *and* ***Nick Norman***

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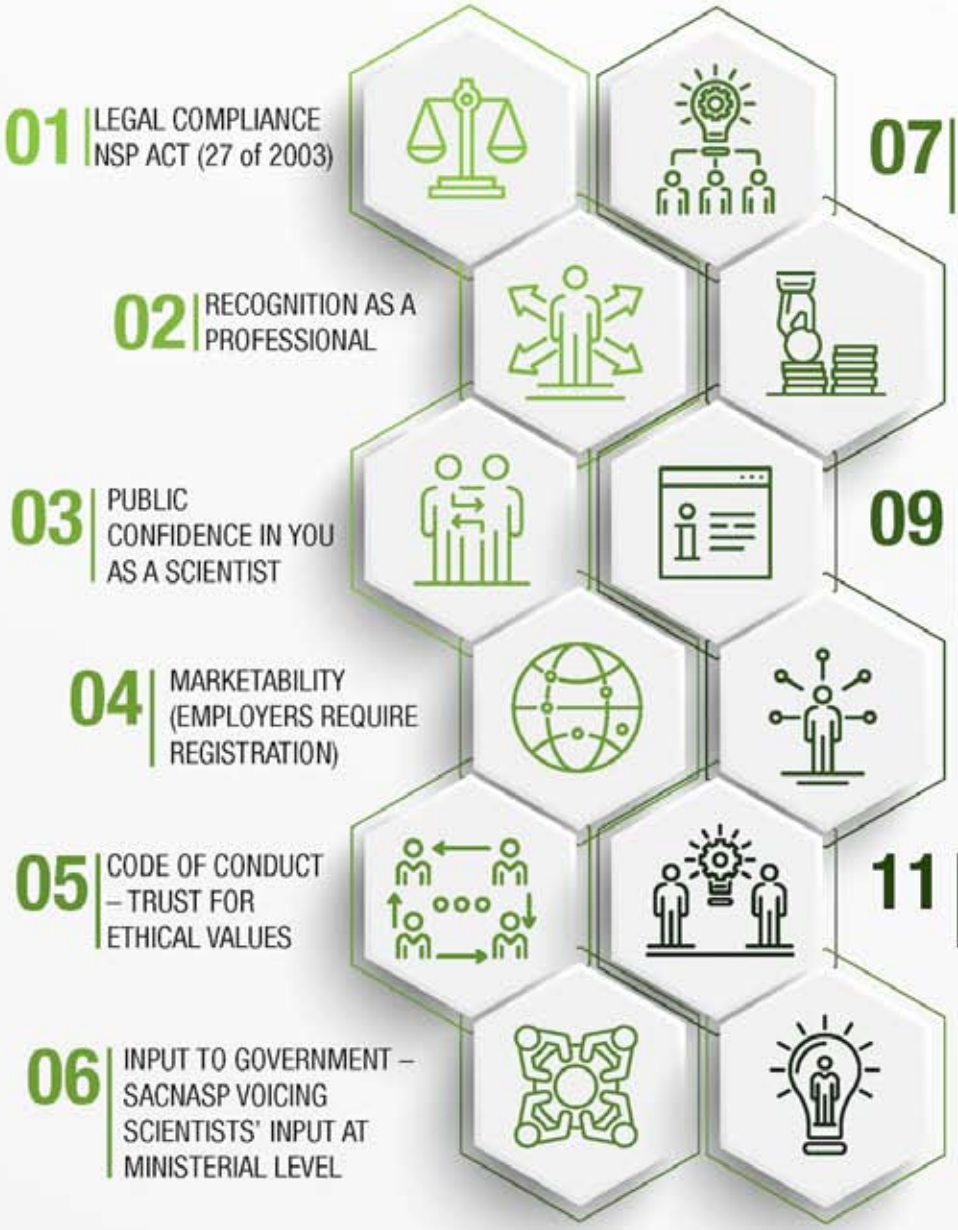

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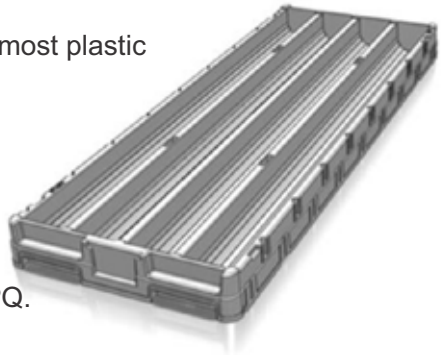

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mineral scene

Cerussite

This Mineral Scene is partly extracted from Cairncross (2022)[1]

Cerussite ($PbCO_3$) is one of the relatively common minerals that forms in the oxide zones and gossans of lead deposits, primarily from galena. Cerussite crystallises in the orthorhombic crystal system, and is typically colourless to white, but inclusions of other minerals or elements can produce red, blue, green or black crystals. One of its morphological characteristics is that it forms beautiful snowflake-like twinned crystals. One of the most famous localities for producing world-class cerussite crystals is the Tsumeb mine in Namibia. There are several other known localities in southern Africa, but none can rival the size and beauty of the Tsumeb specimens.

Cerussite was a common and spectacular mineral at the Tsumeb mine in the Otavi Mountainland, Namibia. Specimens from this mine, including large, multiple twinned crystals, over 30 cm in diameter, that resemble giant mineralogical snowflakes, are to be found in collections all around the world.[2-4] They are colourless or white, often transparent, and can weigh several kilograms. Rare varieties are coloured red, green or blue by the presence of copper-bearing minerals. The Kombat mine was the source of superb cerussite crystals, albeit relatively few in number. These are flawlessly transparent and were often heart-shaped twins. They acted as natural prisms when a light was passed through the crystal.

Other noteworthy localities in Namibia are the Ai-Ais lead mine in southern Namibia, the Uitsab vanadium mine (with galena and pyromorphite) and the Namib lead mine 7.5 km north-east of the Namib railway siding. Some interesting cerussite specimens have been found in the Kaokoveld. The Van der Plas mine has produced 'V'-shaped twinned crystals of 3–4 cm, as well as squat dark

Highly reticulated, twinned cerussite, 8.4 cm. Tsumeb mine, Namibia. (Specimen & photo: Bruce Cairncross)

Typical V-twinned cerussite from the Kombat mine in the Otavi Mountainland, Namibia, 3.9 cm. (Specimen & photo: Bruce Cairncross)

grey varieties. 'V'-twinned white cerussite and more complex twinned forms have been found in gossanous matrix at the Rosh Pinah mine in southern Namibia.[5]

Cerussite is found in South Africa as small (up to 2 cm in diameter), highly reticulated, twinned crystals in some lead deposits. Aesthetic specimens have been found at the Edendale and Leeuwbosch

White, opaque, 1.5 cm cerussite on weathered gossan, Rosh Pinah mine, Namibia. (Specimen & photo: Bruce Cairncross)

☞

Bright red cerussite, 3 cm. The colour is caused by inclusions of red cuprite, copper oxide, in the cerussite. Tsumeb mine, Namibia. (Specimen & photo: Bruce Cairncross)

lead mines in Gauteng and in several of the old lead–zinc deposits in the North-West Province. At the Argent mine east of Johannesburg, cerussite is common as small, water-clear to dark grey crystals, which are usually well-formed simple prisms, but are sometimes twinned.

Bruce Cairncross
Department of Geology, University of Johannesburg
(brucec@uj.ac.za)

Bladed cerussite crystals on gossan matrix, 10.5 cm. Kindergoed farm, Carolina district, South Africa. (Specimen: Johannesburg Geology Museum; photo: Bruce Cairncross)

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obituary

Keith Whitelock †

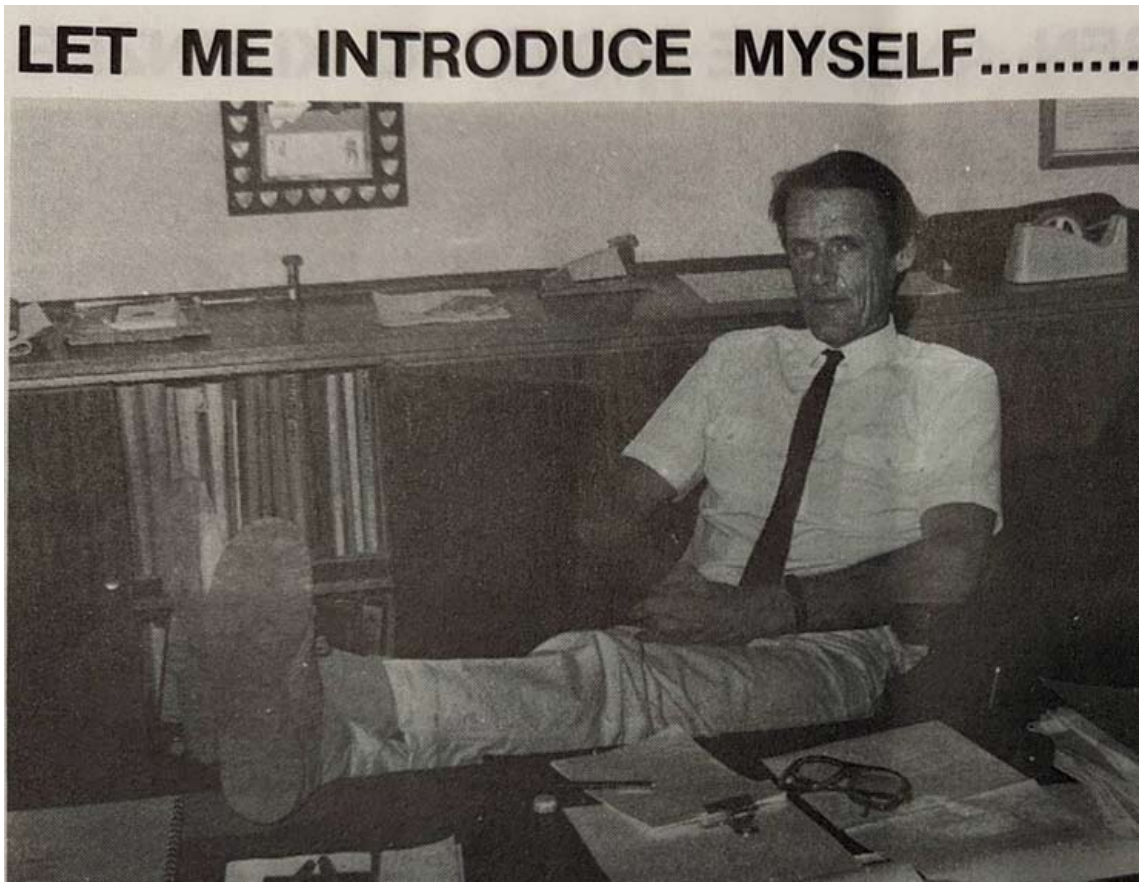
Keith Whitelock
15 July 1933 to 1 September 2023

In memory of a long-reigning champion of the natural diamond industry

Keith Whitelock, mining engineer and geologist rolled into one inspirational leader of—and committed believer in—the natural diamond industry of SADC, passed away on Friday 1 September 2023 at his home in Ficksburg after a 90-year innings. His drive, determination and ability to communicate across all levels, radiating empathy rarely seen in the tough world of mining, made Keith a legend in the SADC diamond industry, where he had played significant leadership roles in both kimberlite and alluvial diamond mining operations, notably in Lesotho, Botswana and Namibia. Concomitantly, he was also a mentor to many, covering the exploration–exploitation–evaluation disciplines, often with a tongue-in-cheek approach to environmental requirements just to get a rise out of the greenies! Nonetheless, Keith believed that economic diamond deposits represented an important resource, not only for shareholders, but also for the host country, the communities neighbouring the mines and to the individuals who worked on, or for, such mines.

Keith cracking a good bottle of Red Wine in the Letšeng pub to celebrate the recovery of the 603 ct Lesotho Promise, August 2006. After day shift, the pub was THE meeting place where Keith kept tabs on the daily production and issues AHEAD of the next day!

Keith kept up his climbing prowess while GM at CDM. Reaching the summit with Stu and Debbie Bowen, Richtersveld, 1990. (Photo: Irene Whitelock)



Keith's arrival at CDM in 1987 brought a different angle to the General Manager's position. (Photo courtesy of the Oranjemund Newsletter, 1987)

His zest for work, accompanied characteristically by a wicked sense of humour (to quote Norman Lock, and confirmed by all who had the good fortune to work with Keith!), was well matched by his ability to play and to party hard. Regardless of the 'Gin and Tonics', the good red wines and the 'Underberg bandolier', Keith always kept fit. He was a top-class mountaineer, hiker of note, and an accomplished skier, maintaining a level into his 80s that was testimony to his strong belief in regular exercise that later incorporated meditation into his routine—much to the surprise of those who were used to his otherwise, hard-hitting work approach in general!

After 66+ years in the SADC diamond industry, Keith left a legacy that touched many people—mostly positively—and involved a number of projects, from world-class size to almost artisanal scale. This brief summary merely highlights aspects of Keith's journey through the SADC diamond world, which many of you will have been party to and will have much better memories than can be distilled here. However, the one achievement that really stands as tall as the +2,500 masl Maluti Mountains themselves, is the pivotal role Keith played in getting the Mountain Kingdom of Lesotho an annual highlight among the World's Top Ten Diamond Producers since the Kimberley Process became operational. His long association with, and unwavering championing of, this kimberlite-rich country, led the Government of Lesotho—at the King's Birthday Celebration on 17 July 2010—to appoint Keith an Officer of the Most Loyal Order of Ramats'eatsana (OMLOR), "In recognition of his outstanding contribution in the diamond mining industry in Lesotho" (which is the smallest diamond producing country in Africa).

Keith was born in England, a Mancunian, and came to South Africa with his family as a young lad, later graduating from the University of Witwatersrand in both Mining and Engineering Geology, having won a Chamber of Mines bursary.

Sometime in the early 1950s, Colonel Jack Scott acquired exclusive diamond exploration rights over the then Basutoland. Kao was officially recognised

as a kimberlite pipe in about 1955, and so soon thereafter regional kimberlite exploration began, as other occurrences were assumed to exist in the Kingdom. On 14 December 1957, two UK-based geological students, Peter Nixon and Barry Dawson, discovered Letšeng. Keith Whitelock began as an exploration geologist with Colonel Scott at about this time, resulting in his life-long love for, and interest in, the diamond deposits of Lesotho.

Keith put the Lesotho Promise on display in the Letšeng Recovery window so that this magnificent stone, the largest recovered in Lesotho at that time, could be seen by the workforce.

In 1959 Jack Scott was joined by Anglo American (De Beers) as Basutoland Diamonds to promote more extensive kimberlite exploration in the Kingdom. De Beers seconded the young South African geologist, Robin Baxter-Brown, to the project, and his team set up camp in the uppermost reaches of the Khubelu River. Keith Whitelock's exploration teams were located in the upper tributaries of the Senqu River, north of Mokhotlong. Camps were basic and designed to be easily mobilised, using pack-mules to move from site to site. Being deep in the Maluti Mountains, beyond the Moteng Pass and Tshletsenyane River, the upper Khubelu and Senqu Rivers were reached by either foot, horse or mule-train. At that time, not long after the conquest of Everest, the mountaineer in Keith was greatly impressed with the low-level, one-man, light-weight tents used by the Everest team. As such, he prescribed the same for each member of the exploration unit. However, for the taller South Africans these tents were a proverbial pain and Baxter-Brown had Keith issue him a bell-tent which, much to Baxter's chagrin, soon was converted to a mess and bridge-playing venue by his co-workers.

Unusual for that era, Colonel Scott had rented a French Alouette helicopter capable of operating with a reasonable payload at high altitude, to take supplies and messages from the base at Leribi to the various field camps. One day, Baxter-Brown received a message from the pilot that Keith had summoned an important meeting for all team members to be held at Mokhotlong, which included the opportunity to meet his visiting 'sister'. To get there from the Khubelu River was a 2-day, strenuous hike, camping en route. On arrival, they found that the 'sister' was in fact Keith's girlfriend, Irene; the couple announced their engagement during that 2-day Mokhotlong party. It was at this time, in the late 1950s, that Keith and Baxter-Brown formed a friendship that was to last the next 65 years.

After the Jack Scott / De Beers exploration campaign ended, Keith moved to Namibia with the Jack Scott

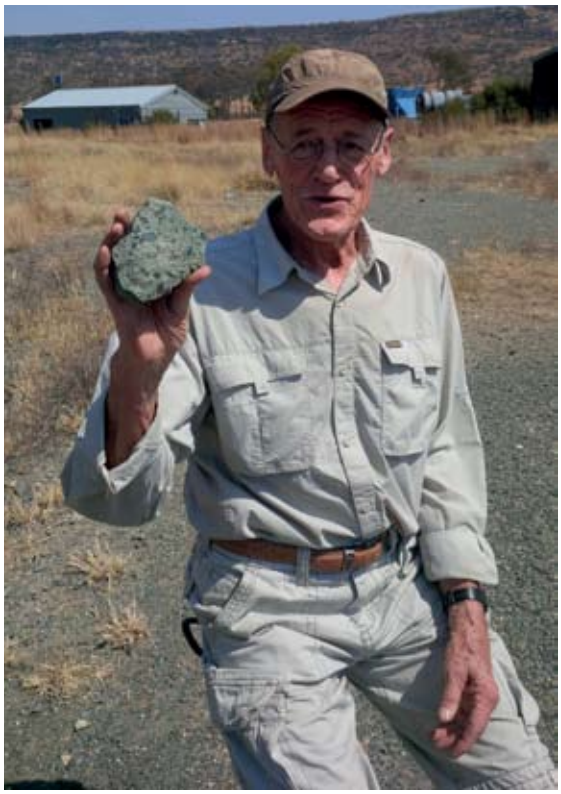
Keith explaining the merits of the Type I diamonds from the high-grade K6 kimberlite at Kao Mine during the test work phase in 2011.

Keith with Diver Lange in Louis Kriel's dredge camp on the Kasai River, DRC, 2003.

group, but this ended acrimoniously, and he parted ways to join Rand Mines. This involved exploring for kimberlite-related rocks in Bushmanland (now part of the Northern Cape), South Africa—a technically successful campaign but one that yielded nothing economic. In hindsight, this was not surprising, as Keith's exploration pre-dated the 1966 breakthrough by the late Professor Tom Clifford, determining that diamondiferous kimberlites were restricted largely to cratons. In 1967, Keith ended his Rand Mines career by mapping and sampling the Monastery kimberlite pipe in the Free State, a locality comparatively close to the Lesotho border, a scene that he would return to some 55 years later….

So, in late 1967 and early 1968, Keith went to work for his good friend Baxter-Brown in Botswana (then Bechuanaland) on the Tati Nickel prospect. As good as the bush was, the area was flat, and devoid of the hills and mountains that would normally provide Keith with rock-climbing opportunities, and it was definitely too far from any snow to ski on! However, in order to keep as fit as he was, Keith hung a long rope in the tallest Acacia tree (incidentally, the Australian stealing of the genus Acacia name is not recognised here!) in the camp and would scale that vertical rope several times a day to maintain his superb fitness. Fortunately, this arrangement did not have to last very long, as Keith managed to get a post back in Lesotho with the Lonrho Group for two years, 1968–1969.

In 1970, Keith moved to Newmont Mining Company where he headed their Maluti Diamond Corporation (MDC) in Lesotho, which evaluated many of the larger pipes already discovered during earlier prospecting campaigns. The seminal work produced during this time culminated in the 1973 "Lesotho Kimberlites"—a book edited by Peter Nixon, with considerable support from Keith, including his ground-breaking scientific paper on the "Morphology of the Kao Diamonds". His paper clearly described the change from the primary octahedral form to the resorbed dodecahedral shape, as the diamonds were transported in the highly corrosive kimberlite magma from the upper mantle to the surface. In 1973, the



Monastery was on Keith's radar again in 2014 as another potential kimberlite source of Type IIa diamonds—based on his original prospecting programme for Rand Mines in 1967.

first International Kimberlite Conference was held in Cape Town, South Africa, and Keith was instrumental in ensuring the success of the field excursions to the MDC operations at Kao, Mothae and Letšeng. A then UCT MSc student, who is now a mature Dr Paddy Lawless, was assisting with the pre-field trip on-site preparations, but due to an accident he was camp-bound at the Kao site. The MDC mining and metallurgical guys were incredibly hospitable, inviting him to the canteen every day after shift closure where drinks flowed freely until supper time, although Paddy could not partake being on heavy antibiotics at the time. This invite was extended for three afternoons until it was mentioned to the mine manager, the legendary Keith Whitelock. He could not decide whether to be cross or amused, because he had decreed, if a visitor was present in the canteen, drinks would be free to all! Needless to say, this was quickly changed to 'able-bodied visitors' and not semi-walking, wounded, doped up MSc students! At the official conference field trip—on the last night at Kao—Keith and Professor Mike O'Hara, a world class, top-level mountaineer, entertained the assembled guests by having races around the main dining room, with no parts of the body permitted to touch the floor. It is not recorded who won!

In 1973, Keith joined De Beers, bringing his encyclopedic knowledge of the Lesotho kimberlites and their diamonds, as well as an excellent understanding of operating in the Maluti Mountains up on the Roof of Africa, to the setting up of a fully-fledged mine at Letšeng. This was after Rio Tinto Zinc (RTZ) had withdrawn in 1972 following two years of surface and underground investigation. The Government of the day approached Mr Harry Oppenheimer to gauge his interest, which was indeed there! Keith was appointed General Manager of the Letšeng Mine in 1974 and the first ore was tipped into the plant in early 1977. This was, and still is, the highest diamond mine in the world at 3,100 metres above sea level, as well as being the lowest grade kimberlite mine in the world, at around 2–4 carats per hundred tonnes (cpht). Consequently, Letšeng was run on a shoestring budget for its production period from 1978 to 1982, when it was closed due to a global slump in diamond prices. As vehicles were scarce at Letšeng during this production period, Keith had a habit of jogging around the mine and to the plant, his large leather-bound notebook on hand for keeping meticulous track of the progress in the various disciplines, and which helped him maintain his characteristic high levels of fitness for his hiking, climbing, and skiing ventures. As Bob Liddle pointed out, with the low-grade kimberlite being hauled out of the Main Pipe in Terex trucks, Keith would remark, "there may be a diamond in that truck"! Another point worth remembering from that time was when a party was held at Letšeng, where alcohol is about 3 times more "efficient" than in the lowlands, Keith apparently would allow the use of the medical oxygen tank to supplement the scarcity at 3,100 masl, promoting more rapid recovery in the days before breathalysers and such restrictions!

In 1981, ahead of the closure of Letšeng in 1982, Keith was transferred to Botswana as the General Manager of the large, world-class, 118-hectare Orapa Mine, and the smaller Letlhakane Mine (which included Damtshaa) —all primary kimberlite pipes. During this period, the well-preserved fossils in the fine-grained sediments of the epiclastic

Keith marshalling his team to tackle Monastery in December 2022. This was his last diamond project that was actively being developed, albeit on the proverbial shoestring budget funded mostly by himself, when he passed away on Friday 1 September 2023.

crater deposits of the Orapa pipe were discovered. Excellent academic work was carried out by Wits at the time, identifying insects, plants, amphibians, etc. of Late Cretaceous age. Around that time, Orapa suffered a plague of cockroaches, which led to a formal complaint being made by one of the town ladies to Keith as GM. He considered her view and then suggested that as cockroaches had been around for at least 70 million years, the chances of eradicating them were pretty slim, so maybe she should learn to live with them instead!

In 1987, he was transferred to Oranjemund to head up De Beers' CDM alluvial operation that covered river, marine, and aeolian sedimentary placer deposits in the Sperrgebiet of Namibia. His empathy for all levels of the workforce and his ability to communicate both down and up those levels were put to good use in transforming the CDM operation into a 50:50 share with the Government of Namibia. This new company was aptly named Namdeb Diamond Corporation (Pty) Ltd. As the end of life of the land-based operations was on the horizon at that time—about 2001—Keith requested new sedimentologically oriented geological "blood" into the West Coast system from the then Anglo Gold Division and Cape Exploration from the De Beers side. This approach was supplemented by a more scientifically rigorous angle provided by the world-renowned, now late Professor Brian Bluck from Glasgow University. This combination, at a tough time for the industry, set a then 5-year exploration programme in place in 1993. However, in typical Keith fashion, there was no roll-over and accept, and there were several heated exchanges where he accused the exploration team (and hence money spenders!) of being "silver-tongued geologists"! However, that was his manner to ensure that the argument for exploration funding was sound and clearly thought through prior to his supporting such an outlandish request for money when the market was down and a mine, Bogenfels, had just been closed in 1992! Fortunately the amassed field evidence tipped his scepticism and he supported the new exploration programme in 1993 prior to his retirement in 1994. This programme was successful and subsequent new, innovative applications to the ongoing development have ensured that the mining licence has been extended to 2042. Furthermore, Keith was "persuaded" to start up an official environmental campaign at CDM/Namdeb, though initially he held that such a venture was indeed useless as we would all one day end up a mere "yellow streak" in the geological record from a nuclear war! But, as usual, he wanted all the facts laid out before he gave that worthy environmental approach and project the official nod! As a normally casual dresser on the mine, Keith would "dress up" for Head Office (Johannesburg, etc) visits in a denim suit—generating fair comment and more from the other, more conservatively dressed GMs of that era! During his tenure as GM based in Oranjemund, Keith continued his rock-climbing activities in the Cape, including the Richtersveld and Table Mountain among others, and in Namibia, inter alia scaling the prominent inselbergs demarcated as the Gross and Klein Spitskoppe.

Keith retired from the formal, large corporate diamond mining sector in 1994, thereafter focusing his efforts tenaciously on obtaining a new mining lease, as well as capital, to "switch the lights on again" at Letšeng. It took five years to secure the mining lease, and another four to rebuild the plant and get the mining fleet and mine plan up to scratch so that production could re-commence in early 2004. During this start up period, Keith ran an alluvial exploration programme on the large Kasai River in the DRC using a dredge that was custom-built and run by Louis Kriel and his team of RSA divers. Although this project did not evolve any further, it gave Keith, along with his early 1980s visit to Mbuji Mayi, an oversight of the DRC alluvial deposits that assisted two junior companies later in their attempts to unlock that inherent potential from 2006 to 2012.

Back in the Maluti Mountains in the late 1990s, and now some 25 years after the 1973 IKC field excursion, Keith supported Craig Smith's request for help on the 2IKC field excursion to the Lesotho kimberlites. In Craig's words: "Keith was absolutely instrumental in organising the Lesotho field trip for the second IKC in Cape Town in 1998. The task fell to Deon de Bruin and myself by default because no one else on the organising committee except JJG (the late Professor John Gurney) knew Lesotho at that time. I met Keith for the first time at Barry Hawthornes' daughter's wedding in about 1996, and he agreed to assist. Without that chance meeting, the field trip might never have happened. It was in the days before Letšeng re-opened, and neither Deon or myself had any experience in Lesotho. There was not much going on at the top yet, and we had to re-locate the various pipes and dykes, as well as make sure we were in the good books of the diggers on Kao—and the army guys stationed at Letšeng. Deon and I would drive to Ficksburg on Friday evenings, and the three of us would drive to the top on Saturday morning. We must have done this between 5 and 10 times. Without Keith's guidance, it would have been a lot more difficult, if not impossible."

The yields of large diamonds, notably the rare, high value Type IIa white gems larger than 20 carats (cts), vindicated Keith's conviction that the Letšeng Main and Satellite Pipes were worth re-opening. In his typical inclusive approach, Keith requested that the white Type IIa gem 603 ct Lesotho Promise, recovered in August 2006, be laid out in a display in the Recovery window, so that the workers could file past during their shift and see what the largest diamond recovered in Lesotho to that date actually looked like! Subsequently, and some 11 years later, the biggest diamond recovered to date has been the Lesotho Legacy at 910 cts, found in late December 2017. The regular recovery of top-quality gem Type IIa diamonds from Letšeng paved the way for the academic research that has opened up in recent years on these rare diamonds. Keith was instrumental in getting the initial information on those rare gems out into the public knowledge and allowed several presentations at GSSA and related meetings, as well as an academic paper to be presented and published at the 8IKC—all under his watch from 2004 to 2008.

In late 2009, Keith turned his attention to the marginal Kao Main Pipe, which at 19.8 ha, is the largest-known kimberlite body in Lesotho and one that he knew well the challenges of from the exploration carried out in the early 1970s. He brought Kao into commercial production in early 2012, after two years of test work and plant construction in 2010 and 2011. Subsequently, the Kao Mine has yielded the third largest pink gem diamond found in Africa to date—a 108 ct Type IIa pink gem recovered on 23 March 2023. Its presence complements over one hundred +5 ct Type IIa pink gems that have been recovered regularly from the Kao Main Pipe since December 2013. While at Kao, Keith actively supported educational initiatives and, for example, he ensured financial support for the university studies of the first professional graduate sponsored by Kao Mine (Storm Mountain Diamonds)—fittingly, a young lady geologist.

After leaving Kao in late 2012, Keith did not slow down nor retire. At around 80 years of age, he

continued pushing the boundaries in trying to bring other, smaller diamondiferous kimberlite bodies to economic account. His first venture was the high-grade Moteti Dyke, operated as the Northern Fissures project in 2013–2015, which proved difficult to execute to a full-scale mine due to its narrow tabular form. This was followed in 2017 to 2019 by an effort to re-open the Samada Pipe in the Free State Province of South Africa. His detailed research back to the original mine operations in the late 1890s, including minutes and diamond records of that early time, and subsequent records up until the late 1980s, indicated to him that Type IIa stones—white and pink gems (as identified by Dr Assie van der Westhuisen in his PhD)—were present in the Samada (Kaalvallei) kimberlite pipe. Keith would later be proved correct in this regard. Then, in 2022 and 2023, Keith returned to the Monastery Pipe, also in the Free State, which he had sampled underground for Rand Mines in 1967. Again, his characteristically meticulous research had pin-pointed a Type IIa source within the Monastery multiple kimberlite volcanic phases. Keith was actively involved at Monastery until his health deteriorated in mid-2023, limiting his customary hands-on, participative management style that was characteristic of all his previous ventures, large and small.

Keith will be long remembered in the SADC diamond industry for his zest for, and maverick approach to, life—both in the workplace and out on the hills climbing, hiking or skiing—and all rounded off with more than a touch of his wicked humour and a drink or three (or more!). He was truly a "people's person" and we celebrate and give thanks to his clear vision and determination to revive the natural diamond industry in Lesotho and South Africa in recent decades, which in the Mountain Kingdom created far-reaching economic and educational opportunities!

Our sincere condolences to Keith's family (one daughter and two sons) and his many friends.

Rest in Peace, *ntate* Keith Whitelock.

Compiled by ***John Ward, Debbie Bowen, Robin Baxter-Brown*** *and* ***Claudia Boffard****, with inputs from* ***Bob Liddle*** *(Letšeng, 1976–1978),* ***Paddy Lawless*** *(Kao, 1973),* ***Norman Lock*** *(Letšeng, 1970s),* ***Graham Wheelock*** *(CDM 1992–1994; Letšeng 2005–2009),* ***Craig Smith*** *(1978; 2004),* ***Louis Kriel*** *(2003);* ***John Bristow*** *(through the years) and* ***Alex Bals*** *(2023).*

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ALEX DU TOIT

MEMORIAL LECTURES

36th A L du Toit Lecture: Eight boreholes and three tunnels: ICDP Project BASE probes the Moodies Group of the Barberton Greenstone Belt

FEBRUARY 2024

CHRISTOPH HEUBECK

Christoph Heubeck is a German regional geologist, sedimentologist and stratigrapher studying deformed sedimentary basins at the pore-to basin-scale worldwide. Following his undergraduate degree at Würzburg University, Germany, he completed his MSc degree in Austin, Texas, and his PhD at Stanford University, California, all in Geology, the latter with research on the Moodies Group. After six years of international assignments in the oil and gas industry with Amoco and BP, Christoph returned to Germany to take up a faculty position at the Freie University Berlin, where he worked with students in the field in South America, China and Kazakhstan. He returned to the BGB with his own students in 2008 and has been active in the region ever since. Community involvement has included the R40 Geotrail and the Barberton-Makhonjwa Mountains World Heritage Site. Academic projects include developing the potential of the BGB in Eswatini and co-coordinating the ICDP research drilling program BASE. Christoph is currently Chair of General and Historical Geology at Friedrich-Schiller-University Jena, Germany.

LECTURE SERIES

Lecture 1 : Stellenbosch University, Western Cape
Date: Thursday, 15 February 2024
Venue: WP de Kock Lecture Hall, Room 1004
Time: 18:00 for 18:30
Contact: Dr Tahnee Otto : tahneeotto@sun.ac.za

Lecture 2 : University of Free State, Bloemfontein
Date: Tuesday 20 February 2024.
Venue: Lecture Hall 1, Geology Department
Time: 17:00 for 17:30
Contact: Ernest Moitsi : moitsime@ufs.ac.za

Lecture 3 : University of the Witwatersrand, Johannesburg, Gauteng
Date: Thursday 22 February 2024
Venue: 'GLT' ground floor Geosciences Building, East Campus, Wits University, Braamfontein
Time: 18:00 for 18:15
Contact: Dr Grant Bybee : Grant.Bybee@wits.ac.za or Robyn Symons : robyn.symons@wits.ac.za

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Lecture 4: University of KwaZulu-Natal, Durban, KZN
Date: 26 February 2024
Venue: UKZN Westville Campus, Senate Chamber
Time: 17.00 for 17.30
Contact: Dr Tanja Reinhardt : Reinhardtt2@ukzn.ac.za

36th A L du Toit Lecture: Eight boreholes and three tunnels: ICDP Project BASE probes the Moodies Group of the Barberton Greenstone Belt

Units of the up to 3.7 km thick Moodies Group (~3.22 Ga) of the Barberton Greenstone Belt, South Africa and Eswatini, comprise some of the oldest and best-preserved, sedimentary strata on Earth. They were deposited within a time span of only a few million years in alluvial to pro-deltaic settings, with a dominance of coastal plains and tidal deltas.The strata consist of widespread quartzose, lithic, tuffaceous and arkosic sandstones, polymict conglomerates, common siltstones and shales, and rare BIFs and jaspilites, all interbedded with rare dacitic air-fall tuffs and several lavas. Moodies Group strata preserve abundant sedimentary structures and represent a very-high-resolution record of Paleoarchean surface processes. Microbial mats, early diagenetic vadose-alteration zones and tidal rhythmites are locally common. Moodies Group strata provide a unique opportunity to investigate Paleoarchean surface environments and to constrain the conditions under which bacterial life spread and thrived in coastal-zone and terrestrial settings on Early Earth.

The ICDP Barberton Archean Surface Environments (BASE) Project drilled eight inclined boreholes of 280 to 497 m length through steeply inclined or overturned Moodies Group strata between November 2021 and July 2022. The unweathered and continuous core record was complemented by sampling in three several-km-long tunnels and by detailed surface mapping. Two to three rigs operated concurrently, delivering 20 to 60 m of high-quality core daily. This core was processed in a large, publicly accessible, hall in downtown Barberton. An exhibition provided background explanations for visitors and related this fundamental-geoscience research project to the geology of the Barberton-Makhonjwa Mountains World Heritage Site. The archive half of the core, nearly 3 km total, remained in South Africa, the working half is curated at the ICDP core repository in Berlin, Germany.

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15 & 16 NOVEMBER 2023

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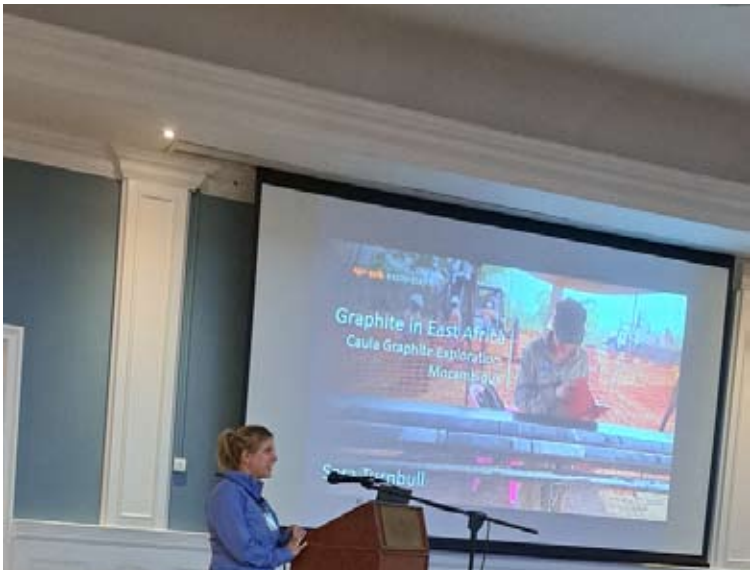

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REQUEST FOR APPLICATIONS TO THE RESEARCH, EDUCATION AND INVESTMENT (REI) FUND OF THE GSSA CLOSURE DATE FOR APPLICATIONS: 31 JANUARY 2024

The GSSA Research, Education and Investment Fund (REI Fund) is inviting applications from GSSA paid up-members (including post-graduate student members) for grants from the Fund, to be received at the GSSA office not later than 31 January 2024. Applications can be made using the prescribed application form available under Publications/GSSA Documentation on the GSSA website (www.gssa.org.za) or see the link below for the online form. Supporting information required with each application includes a short description of the project, brief motivation for research and funding requested, a budget describing how funds will be used, and a letter of support from research supervisor (in cases where the applicants are post-graduate students at South African universities). Post-graduate student members applying for financial support must have been a member of the Society for at least one year. Applications from current student members with a PhD qualification are not accepted unless the applicant has applied for transfer to or is registered as a full paid-up member of the Society.

https://www.cognitoforms.com/GeologicalSocietyOfSouthAfrica/researcheducationandinvestmentfund

Grants are intended to support a variety of earth science research costs, including analytical and field costs, conference attendance, and publication costs. Projects that promote and support earth science awareness such as geoheritage, geotourism and geo-education may also be supported. Expenses related to (annual) registration and tuition fees, text books, accommodation, etc. required at Higher Education Institutions are not covered. Members enrolled at non-South African universities are not eligible to apply for financial support.

In particular we welcome applications from post-graduate student members and would appreciate it if Heads of Departments at Higher Education Institutions and their staff would inform their students of this opportunity. Grants are usually limited to R25 000 per application, but well-motivated applications for larger amounts are also welcome. All applications will be judged on merit and/or the importance to the Society in promoting its image. Note that grants are only awarded to members/student members in good standing.

Applications are screened by the REI Fund Committee during February/March with input and ratification by the GSSA Management Committee and Council, respectively. In evaluating the applications and recommendations, the Committee considers the merit of each application, and depending on the amount of money available for that year, makes a final decision on the allocation of grants for that year. The decision of the Committee is final and no further correspondence on the matter will be entertained. By following this procedure it is anticipated that applicants will be informed during March 2024 whether or not their applications are successful. Recommendations made by the Committee require Council approval, which may delay notifications.

The current members of the REI Fund Committee are: Reinie Meyer (Chairman), Frank Gregory, Bertus Smith, Rob Ingram, Derek Kyle, Steve McCourt, Richard Viljoen, Mike Wilson, Grant Bybee and two office bearers of the Society who have ex officio status, namely the President (Dr Steve McCourt) and the Executive Manager (Craig Smith).

RHODES UNIVERSITY
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LECTURER/SENIOR LECTURER IN ECONOMIC GEOLOGY OR HYDROGEOLOGY

Post description: The Department of Geology seeks qualified applicants for a tenure-track faculty position in either the field of Economic Geology or Hydrogeology to commence by 1 July 2024 or as soon as possible thereafter. The post-holder's primary responsibilities are teaching of undergraduate and postgraduate courses in either Economic and Exploration Geology or Hydrogeology and related geophysical methods. The incumbent is expected to develop a successful externally funded research program including postgraduate student supervision.

Requirements: The successful candidate will have a PhD and an appropriate research track record either in the field of Economic Geology or Hydrogeology. In Economic Geology experience in a range of metallic ore deposits is required. Experience in critical metals would be an advantage. Hydrogeology may include the physical and chemical aspects of groundwater research (e.g., groundwater exploration, development and monitoring). Previous work will have resulted in peer-reviewed publications in international journals as appropriate to the level of the post. Relevant teaching experience and MSc or PhD student (co-)supervision are requirements as appropriate to the levels of the post.

Opportunities: Start-up research funding is available from university sources. Economic Geologists find various collaboration opportunities with existing staff members and can access competitive in-house funding for doctoral and postdoctoral research fellowships. In Hydrogeology, close cooperation with a successful research group in the Institute of Water Research offers involvement in several ongoing and forthcoming groundwater projects. Career progress to Professor level is merit-based.

Diversity: Recognising that diversity is important in achieving excellence, Rhodes University strongly encourages South African members of underrepresented designated groups as well as persons with disabilities to apply. Qualified spouses and partners of existing staff members are also encouraged to apply.

Remuneration:

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Senior Lecturer:	
Cost to Company Approximately (annual):	R 899 440.00
Basic Salary (Annual):	R 631 639.00

Application: Applications should be submitted online by accessing the Rhodes University website. Applications must include a CV, letter of motivation, application form, copies of qualifications and relevant transcripts. Failure to submit all the required documentation will result in an application not being considered. Information about the selection process and full minimum requirements for this post are contained in the above link.

Closing Date: 15 January 2024.
(There is a possibility that the post may be subsequently readvertised for a two week period following this deadline, for compliance with transformational administrative requisites. All applications received prior to this reposting will still be retained for consideration, so you don't need to apply again nor assume that your application has been declined if that should take place.)

Contact: For further information contact the Head of Department, Prof. Stephen Prevec: e-mail: s.prevec@ru.ac.za; phone: +27 (0)46 603 8313.
For technical questions related to the application please contact Ms Mericha Maccario on +27 (0)46 603 8001.

Administrative: All applications will be treated in strict confidence. This post is advertised as permanent post, but the University may opt to appoint on a fixed-term contract of not less than three-years. The University reserves the right not to proceed with the filling of the post. An application in itself does not entitle the applicant to an interview. Employment checks will be conducted on recommended candidates. Please apply online by accessing the Rhodes University Website.

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1. ADVERTISING RATES (Incl. VAT & Agency Commission)

Geobulletin is published by the Geological Society of South Africa (GSSA) and appears quarterly during March, June, September and December each year in digital and print format.

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December issue:	15 November 2024

5. CANCELLATIONS

At least 4 weeks prior to deadline

6. CIRCULATION

Geobulletin is issued in digital format to all members of the GSSA and its local and overseas exchange partners. A printed option is also available for those who opt for it, and the electronic version is available as an open access download on the GSSA website.

7. ADVERTISING BOOKINGS AND SUBMISSION

Contact person: GSSA
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8. ADDITIONAL CONTACT INFORMATION

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3. The Origin and Evolution of Kimberlites and Related Magmas
4. Diamond Deposits – Exploration and Mining
5. Cratonic Mantle – Petrology, Geochemistry and Geophysics

FIELD TRIPS

1. Northwest Territories Diamond Mines
2. Kimberlites from Across Canada
3. Slave Craton Geology
4. Northwest Territories Kimberlite Drill Core Collection
5. Advances in Drift Prospecting for Kimberlite in Canada

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Invited speakers present a state-of-science summary covering emergent topics followed by moderated questions and extended discussion.

1. Kimberlitic Olivine: Tracking Mantle Cargo and Kimberlite Melt Evolution
Dr. Geoffrey Howarth, University of Cape Town, South Africa

2. Large Type-II Diamonds: Genesis and Transport to Surface
Dr. Evan Smith, Gemological Institute of America

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