GSSA
Geological Society of South Africa

geobulletin

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news


GSSA
Geological Society of South Africa

contents

Front cover photo:

View along strike north-eastward in the central Barberton Greenstone Belt from Shokohlwa (1898 m), the second-highest peak in the Barberton Greenstone Belt. All strata in view lie on the ca. 3.7 km thick, steeply dipping and overturned limb of the Saddleback Syncline, currently being drilled by four boreholes of the BASE (Barberton Archean Surface environments) project. Stratigraphic up is to the left; Lomati Delta Complex is in the left foreground. (Photo: Christoph Heubeck)

For more about the BASE ICDP drilling project, go to pg. 18.

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guest editorial

Carl Anhaeusser

A Geologist Recalls The Past

I was approached by the Editor of *Geobulletin*, Trishya Owen-Smith, to contribute some memories reflecting changes I have witnessed over the 60 plus years that I have been associated with the science of Geology. I began my academic training as a student in the Department of Geology at the University of the Witwatersrand in 1958 and spent an enjoyable 4 years ultimately, being rewarded with a BSc followed by a BSc Hons degree at the end of 1961. I was then fortunate to have been offered a scholarship by my mentors, Prof Desmond Pretorius, Director of the Economic Geology Research Unit (EGRU) at Wits, and Chris Roering, to undertake a research project in the Barberton greenstone belt—specifically on the Lily Gold Mine and surrounding areas. So began my long and productive association with EGRU (later to become an Institute—EGRI) and, more specifically, with Economic and Archaean geology.

So much has happened during my lifetime as a geologist that I can only attempt to recall some of the main events that I experienced. To start with I believe I was just an average student during my early university days and only really began to appreciate what geology was all about when I began working on my own Masters project, where I was required to map and understand the nature of the gold mineralisation and the geological setting of the Lily ore deposit. Together with my colleague, the late Morris Viljoen, we mapped the northern contact of the Barberton greenstone belt and the adjacent granitic terrane. This study led to further mapping of contiguous areas of the greenstone belt and the development of revised ideas on the stratigraphy, structure and granite evolution of the Barberton region as a whole.

In my early years at Wits we were taught to identify ore minerals using a Bunsen burner and platinum wire. X-ray analysis was in its infancy and Rb-Sr isotope analyses in the early 1960s gave us some idea of the age of the rocks we examined in the field—but nothing like the precision now possible using U-Pb zircon dating and other techniques. Identification of rock thin sections was carried out using a monocular microscope and wet chemical analyses were an expensive luxury only a few researchers could afford. It was only later, around 1970, that XRD analytical techniques became generally available. Geologists had to rely mainly on detailed field mapping, which received a boost when improved aerial photographs became available. How early field geologists undertook regional mapping without these aids still amazes me. What the old timers would have given for a look at today's Google Earth and other satellite imagery. We did not have computers, calculators, TV, cellphones or the internet—yet, without these modern facilities that everyone now takes for granted, we seemed to get by well enough. I marvel at some of the early maps of the Archaean greenstone belts produced by geologists associated with the then Rhodesian Geological Survey. Their maps are still, to this day, without equal and were all prepared following protracted and detailed fieldwork.

As students we were influenced by the writings of eminent European geologists who at the time described regional geology and mountain building in terms of geosynclines and the gravitational instability of the crust. A notable few, such as Alfred Wegener in 1912 and again later Alex du Toit in 1937, sowed the early seeds of doubt as to how the Earth's crust behaved. These geologists were vindicated in their thinking that the continents 'wandered around' and played a significant role in crustal processes when, in 1963, Vine and Matthews provided the definitive geophysical

scientific support for sea-floor spreading that led to the now universally accepted concept of Plate Tectonics. The problem today revolves around not if, but when, plate tectonics first became operative, some claiming it started in the early Eoarchaean or Palaeoarchaean (ca. 4.0–3.6 Ga) continuing through to the present, while others support the view that it succeeded vertical geotectonic regimes only after the Mesoarchaean (about 3.2 Ga or later).

The concept of Plate Tectonics was, without question, the most significant scientific advance in the Earth Sciences during my lifetime. While this discovery operated on a global scale, I was fortunate to witness numerous smaller-scale discoveries that bear mentioning. The Witwatersrand gold discovery in 1886 led to the rapid development of mines along the outcropping surface region of the Central Rand and between Springs (East Rand Goldfield) and Randfontien (West Rand Goldfield). Later extensions were discovered in the West Wits area using geophysical methods, mainly involving the use of a magnetometer by Rudolf Krahmann in 1937. Subsequently, extensions to Wits goldfields were discovered during the period I was a student and shortly thereafter. These discoveries included the South Rand Goldfield—a southerly extension of the East Rand Goldfield—significant extensions to the Klerksdorp Goldfield, the Welkom Goldfield, extensions to the West Wits Goldfield and lastly the Evander Goldfield. Geophysics played a dominant role in most of these discoveries, aided by deep drilling and excellent geological input. In the years that followed, no new goldfields have been found—only extensions to existing mines in the respective known goldfields. This has resulted in a steady decline in South Africa's once dominant position in the world as a gold producer. The once powerful mining companies that were a feature of the mining industry in South Africa (including Anglo American, Goldfields, JCI, Rand Mines, Anglovaal, General Mining and Union Corporation—the latter two restructured later as Gencor) have all but disappeared from the gold mining stage.

Other discoveries of significance made during my early days as a geologist include the Phalaborwa Complex in Limpopo Province, which still produces copper, apatite, vermiculite, magnetite, baddeleyite, uranium, nickel, gold, silver, platinum, and palladium (on a student field trip in 1959 I recall having climbed a hill known as Loolekop that is today the giant open pit of the Palabora Mine). Other discoveries in my time include the Prieska Cu-Zn deposit, extensions to the Kalahari manganese field and the Sishen iron deposits, and the Aggeneys Zn-Pb-Cu-Ag mine, all of which occur in the Northern Cape. Patrick Ryan, a student colleague of mine at Wits, had much to do with the Aggeneys discovery and the subsequent development of this deposit for the US-based company Phelps Dodge.

Other important discoveries made in my time included the Orapa and Jwaneng diamond pipes in Botswana and the Finsch and Venetia occurrences in South Africa (I can claim some involvement with the Venetia discovery, together with geologists Jan Mostert of Anglovaal and later Alex van Zyl of De Beers—see *Geobulletin* 03/2012). Important uranium deposits were located in the Damara Belt centred around Rössing Mine in Namibia and recent indications suggest that the old Uis Tin Mine, developed initially by Iscor, is today showing renewed promise as a world class tin, lithium and tantalite occurrence.

No story would be complete without reference to the Bushveld Complex and the discoveries made in this amazing intrusion. Numerous Pt-Pd, chrome, and titaniferous magnetite deposits have been located in the various sectors of the complex, including the major new Pt and Pd discoveries in the Northern Limb and Waterberg areas north of Mokopane.

Sadly, no further mineral deposits of note have been found in more recent times in South Africa, but this highlights the past successes and capabilities demonstrated by our 'old timer' geologists. Of concern today is the fact that exploration has not

been high on the agenda in South Africa in recent years and government interventions, or the lack thereof, appear to be placing too many obstacles in the path of mineral exploration and mining in this region.

I count myself fortunate that I have borne witness to much of what has been discovered in the past 60 years in the southern African region. I have also had the pleasure of meeting many of the geologists that have been successful with these mineral discoveries. It has also been exciting to meet many of the outstanding geologists of yesteryear that influenced my own career and development over the years. These individuals, from both the mining industry and academic circles, have provided guidance and support for my own activities and many appear as Draper medallists in lists produced by the Geological Society of South Africa. Regrettably, many of these colleagues have passed on and only reflect in my memories of the past.

I have witnessed many changes to the Geological Society over the years. As a member of Council for more years than I can remember and as Honorary Editor of the Societies publications for much of this time, I was party to the research being undertaken in the country, both by the university fraternity and the corporate sector. I believe the *Transactions* and, more recently, the *South African Journal of Geology,* has produced a wealth of outstanding geoscientific contributions that can compete with the best in the world. Field studies are, however, progressively giving way to advanced analytical studies. This new approach has its place in the evolution of the geological sciences as the research today is providing added value to earlier studies where modern facilities were not available. It is encouraging to see that the field studies have not entirely been abandoned and I remain convinced that there are still some exciting new discoveries awaiting to be revealed.

This short interlude with the past reminds me that I should actually sit down and prepare a more comprehensive account of my memoirs before I lose track of things altogether.

Carl Anhaeusser *is Professor Emeritus in the School of Geoscience at the University of the Witwatersrand, Johannesburg, and a former Director of the Economic Geology Research Unit/ Institute at Wits.*

executive manager's corner

Craig Smith

The news headlines of the first week of March have been dominated by the Russian invasion of Ukraine (and it is most definitely an invasion and not a low-level military action!). After a week of warfare, the early stage has not resulted in a swift capitulation of Ukraine. Irrespective of whether the major cities fall or not, there will be long-term distortion of the economies of both countries due to sanctions on Russia and reconstruction needs in Ukraine. And this does not factor in the refugees fleeing from the war. There are liable to be impacts on the global resource markets, as we are seeing with the oil

price increase, which will hopefully be temporary. However, there are no guarantees, but both Russia and Ukraine are mineral exporters. As of writing, the resource shares on the Johannesburg Stock Exchange are soaring, in part because of current commodities boom, but augmented by the war in Europe. The question is when the party will end.

The conflict has kept other important events out of the public eye. The COVID pandemic is taking a back seat, hardly getting a mention in the back end of the news. But it is still with us, so don't forget to get vaccinated or boosted. Watching sporting events in the United States gives the impression the pandemic is over, because there are packed stadiums with barely a mask in sight. It is not over; I have been told that a recent search for an ICU bed in northern Illinois—which includes Chicago—came up with one available bed.

The Intergovernmental Panel on Climate Change (IPCC) released the Working Group II report at the end of February, following on from the Working Group I report released last year. That report was focused on the science; the latest one entitled 'Impacts, Adaptation and Vulnerability' examines societal impacts and mitigation capacity of dealing with climate change over the short-, medium- and long-term. The outlook is not optimistic for various parts of our planet. But the report is also not easy to read, given the bureaucratic language and length (96 pages). Some of the diagrams used make little sense because they are too complex. The report and summaries are not likely to be easily digestible by the public, which is the key stakeholder group that needs to be aware of the implications—because they vote in the politicians who set the policies. I would urge the IPCC to release a five-page summary written in language that is understandable, and then market appropriately. It may scare the pants off the general public, but the capabilities and consequences need to be understood by all.

The online Geoheritage meeting in early April should be of interest to all earth scientists, and attendance is free. Details are included elsewhere in this issue of *Geobulletin*. There is a solid and varied programme, and a number of speakers will focus on issues such as geotourism and marketing, in addition to the usual project-level initiatives that are ongoing across South Africa.

Last year was a bumper year for the *South African Journal of Geology* (SAJG), with three of the four issues being special issues. I would like to thank Marlina, Mike and Steve as well as guest editors, contributors and reviewers for all their efforts in making the SAJG a success. The journal is recognised worldwide as a high-quality and independent scientific journal. It is generally regarded as the 'journal of record' for southern African geoscience and is read globally. SAJG is distributed through Geoscience World (the millennium collection from 2000 on), and SABINET (the heritage collection from 1895 to 2000). The latter is open source; the former is free to all members of the GSSA, but is behind a paywall for non-members. Distribution is in digital format, though print copies can be organised at additional cost. Editions post-2000 that are currently only available through Geoscience World will soon also be available via SABINET, behind a paywall (pre-2000 issues will remain open-source). There are a number of good reasons for authors to publish in the Journal, not least of which is wide exposure to anyone interested in southern African geology. Importantly, there is no cost or page charge to authors, unless there is a requirement for open-source publication, which is an available option. Even if that is the case, the page charges are much less costly than any we are aware of. Publish in the SAJG; you will not regret it.

Craig Smith

president's column

Tania Marshall

The GSSA has long recognised the importance of Branches, Regional Centres and Divisions to our members. The Branches/Regions have always been able to address the needs of the local members more easily than the main Society. Because they are in direct and personal contact with individual members, they are more easily able to organise local fieldtrips and informal talks that speak directly to community interests. Likewise, Divisions bring together like-minded folks from disparate regions, but with a common focus.

As of the beginning of 2022, the GSSA supports the following active Branches, Regional Centres and Divisions:

- Barberton Branch, Bushveld Branch, Egoli Branch, KZN Branch, Northern Cape Branch, University of Venda Branch and the Western Cape Branch.
- ESG Division, Geoheritage Division, Groundwater Division, MINSA and the Student/Young Geoscience Professionals Division. One or two more are in the pipeline—watch this space!

I remember as a student that the Branch/Division events were always well attended and that was primarily where networks were developed. It is with this background that I thought it was opportune to highlight the exciting events that are taking place within our Branches, Regional Centres and Divisions (B&Ds). From this edition onwards, you can expect to see a quarterly update of the events (past and future) of our B&Ds in the *Geobulletin*. We have also created a brand-new webpage on the GSSA website, which will be used to showcase events and activities and provide contact details—please look in at it from time to time. We hope it will spur you on to join one or more of these branches or divisions.

There are a number of inactive Branches, having been badly impacted by the Covid-19 pandemic and/or other issues. Please look at the website and contact us (info@gssa.org.za) if you think that you would like to assist in reviving a particular branch.

Tania Marshall

letters

To the Editor,

South Africa's abstention in the recent vote on the UN resolution on Ukraine should not have come as a surprise to anyone. The democratically elected government of this country is an alliance between the ANC, COSATU and SACP, with political and moral philosophies that were honed in Eastern Europe during the Cold War. Furthermore, South Africa is a member of BRICS and so has important economic links with Russia; of that group, only Brazil voted for the resolution. Given this background, abstaining was always going to be the outcome.

What should be of major concern to the Geological Society of South Africa is the directive from the Department of Science and Innovation that public science organisations, and the NRF is specifically

mentioned, "*should not engage in any action of any kind which could be construed as a political comment or political reaction to developments in Ukraine*". It does beg the question as to who is the judge of exactly what constitutes a political comment or reaction. Furthermore it is fairly safe to assume that this directive was not due to concern that science organisations would issue statements fully supporting the invasion, thereby undermining the government's decision to abstain.

The facts in this issue are clear cut. President Putin has stated that Russia has undertaken a special military operation in Ukraine with the specific purposes of de-Nazifying and de-militarising Ukraine, and has indicated that statehood will be removed once this has been achieved. This unprovoked invasion of a sovereign state and the appalling events in the ongoing war have induced even the historically neutral Sweden and strictly neutral Switzerland, neither of which are in NATO, to climb down on the morally correct side of the fence and send assistance to Ukraine.

To abide by the DSI's directive is not only morally indefensible but against the Constitution of South Africa, which gives its citizens the right to free speech. It sets a deeply disturbing precedent that is the thin-edge of a wedge that could lead to a situation whereby, in future, public science organisations may not only be forbidden to make comments but also not be allowed to publish scientific results that contradict statements made by their political masters. This is a tactic used in totalitarian states and is reminiscent of South Africa under apartheid.

Therefore the undersigned request that the GSSA, which is not a public science organisation beholden to the DSI:

- Either executively decides to send a message or rapidly polls members' opinion for a message of support to fellow geologists in the Ukrainian Association of Geologists and the Ukrainian Geological Survey deploring the situation in that country, which has been entirely brought about by the Russian invasion;

- Challenges the DSI's directive and insists that all science organisations should be permitted the freedom to make public the findings of its research and/or to make statements that the collective conscience of its members supports regardless of whether this is in agreement or disagreement with government decisions.

Prof. Mike Watkeys *FGSSA,* ***Prof. Jock Harmer*** *FGSSA,* ***Dr John. Bristow*** *FGSSA*

all the news fit to print

University of Stellenbosch

Everyone is back!

The Department of Earth Sciences at Stellenbosch University is very pleased to get its academic year underway. On an auspiciously lovely day (Valentine's Day), the first, second and third year students were warmly (38 °C) welcomed back to campus for the commencement of classes. Honours students have already been on campus for three weeks, having completed various courses in scientific writing, mineral economics, and environmental analytical chemistry. The staff have been back for even longer and have been desperately trying to write scientific papers before their teaching responsibilities begin in earnest (see von der Heyden et al. *in prep.* **a**, von der Heyden et al. *in prep.* **b,** and so on and so forth until von der Heyden et al. *in prep*. **q**; all in in prep. since 2010).

Under the level 1 restrictions, Stellenbosch University follows an Augmented Remote Teaching,

☞

First year students at a welcoming lecture provided by several of the SU Earth Science staff. Social distancing protocols are followed at all times during ARTLA teaching.

Learning, and Assessment model. Fortunately, with the Earth Sciences' smaller classes and the large venues accessible to us in the Chamber of Mines Building, most of our teaching is, as far as possible, in face-to-face format. The interpersonal contact achieved through being in a classroom environment is certainly more beneficial for both the students and the lecturers alike. Student numbers are looking healthy, and we have enrolled 21 Honours students into our 2022 programme. They include five candidates who come from different undergraduate backgrounds, and so bring with them a diverse set of skills and perspectives into the Honours cohort.

SU Earth Sciences now has a greater social media presence

To keep abreast of modern trends and to better interact with past, current and prospective students who are all becoming more familiar with and reliant on social media interactions, the Department of Earth Sciences at SU is very pleased to announce the release of its own Facebook, Twitter, Instagram and Tiktok accounts. These accounts are being kept current and interesting by MSc student Emma Davies, who aims to encourage interest in both the department and in the broader field of Earth Sciences. We hope that by connecting with prospective students through these platforms, we will continue to attract a throughput of interested and high-calibre earth science graduates. For more information, follow the QR codes posted here, and see additional links at our existing Departmental webpage: http://www.sun.ac.za/english/faculty/science/earthsciences.

Geocongress in Stellenbosch in 2023

The early meetings are underway to ensure that the Geocongress (initially planned for 2020) will finally get underway. The Local Organising Committee (LOC) is already hard at work preparing the groundwork for the event, which we envisage will run between

The various social media platforms on which the Department of Earth Sciences is now active. Follow the QR codes for direct links to the respective platforms.

The Honours cohort for the SU Earth Sciences 2022 Honours program.

11 and 15 January 2023. These are still early days, but the LOC is fully committed to bringing together an exciting and action-packed programme. Please keep your eyes open for various GSSA posts and mail-drops, which will detail additional information about the event as the planning progresses.

Bjorn von der Heyden

branches & divisions

Northern Cape Branch

"In a world where nothing ever stays the same, we all need to change, evolve, succeed... and change again".

That is what we have done, together. The Northern Cape Branch, through Covid19 Lockdown, focused on maintaining stable branch function and momentum gained since the reconstitution in 2019. Through this time, the branch has seen success, building from strength to strength. From the event at Red Sands, long before the Covid19 outbreak, meeting atop of Rhenosterkop hill, and recently being hosted by Orion Minerals in Copperton while the committee finalised 2022 major events and milestones. All these events highlight our commitment and mark our collective intention of creating a social venue for the group of individuals interested in the sustainability of the Northern Cape a heart-felt reality.

Indeed, change has come again. This time in the form of a new committee, which is a kaleidoscopic union of passionate, skilled and playful leaders. These leaders take the branch forward to the next milestones. Together, we'll continue to drive the success of the Branch and the interest of the stakeholders. Over the page are the faces of the members trusted to lead the branch. Of course, none of this would be possible, as always, without the sponsors. Join us in making sure that we have an even better 2022.

The committee wishes to express gratitude to Orion Minerals PCZM for hosting us for the first 2022 strategy session in Copperton.

2022 Upcoming Events

Look out for the following events on social media and other GSSA communication platforms for the 2022 calendar:

- **Wild Wild West: West Coast Diamond Deposits – 1st to 2nd April 2022**,
- Collaboration events with NC SAIMM branch – *TBA*,
- Structural Geology event – *TBA*,
- Membership survey on local skills gap assessment – *TBA*,
- Online Talks – *TBA*.

Masibulele Zintwana

Committee members

Masibulele Zintwana - Anglo	Loni Gallant - Orion	Joshua Kilani - RES	Onwaba Semane - Afrimat	Francois Stassen - Master Drilling
Chairperson	Vice-Chairperson	Secretary	Treasurer	Deputy Treasurer
				

Rounelda Cloete - Alexkor	Darryl Bennett - GW Minerals	Deon du Plessis - Earthlab	Elmar Human - Minrom	Kogi Kovindsamy - Consulting
Communications	Member	Member	Member	Member
				

Palesa Boikanyo - South32	Tricia Scott - Anglo	Vince Schaper - MaxGeo	Deon Bowers - Alexkor
Member	Member	Member	Member
			

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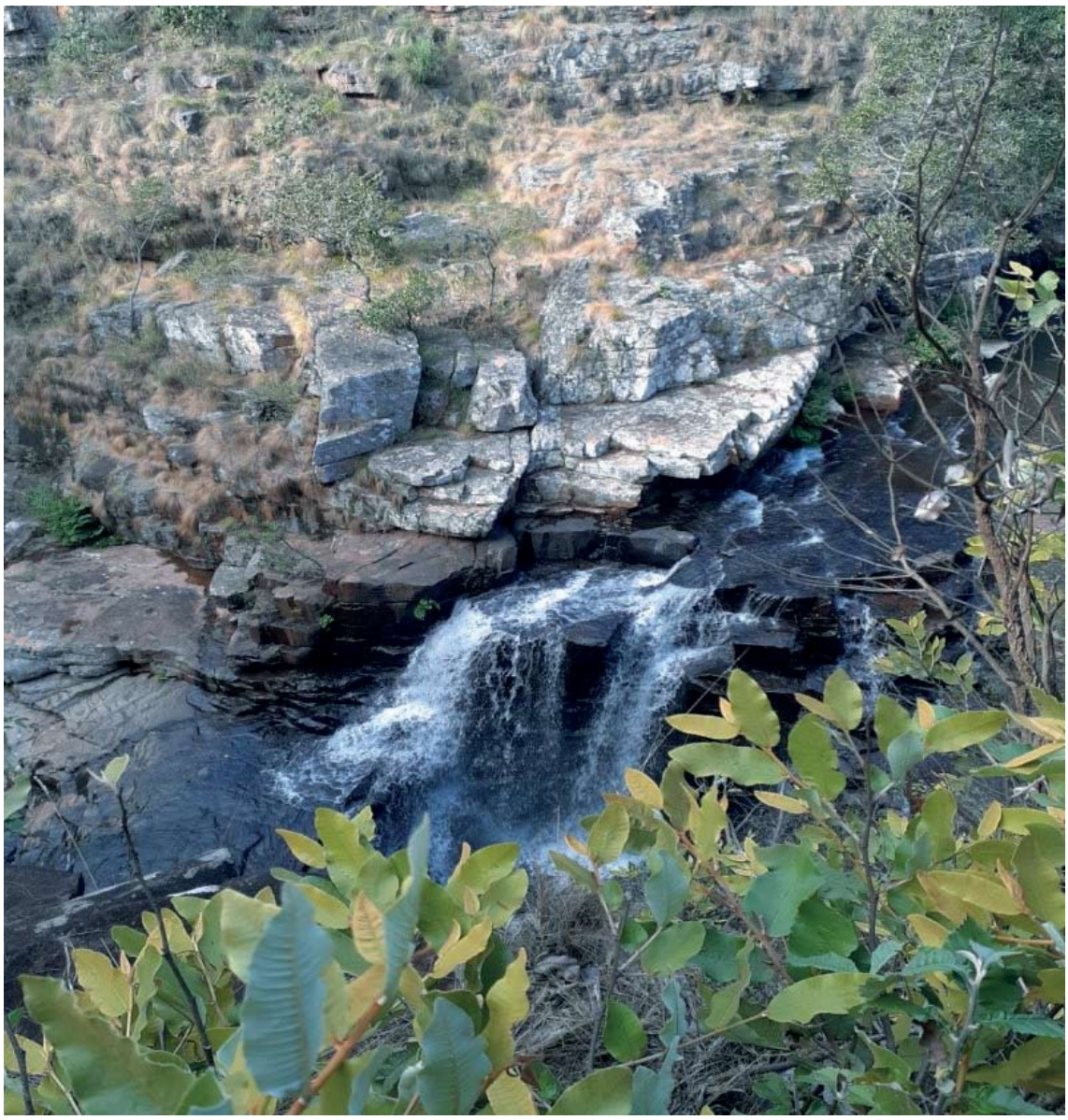
Strategy session pictures

University of Venda Branch

GSSA UNIVEN BRANCH 2022 ANNUAL PLAN

Activities	Venue	Dates
Welcome function	Makapans valley or Mapungubwe	February (1st–2nd week)
Geo-talk (Coal Mining & Future of Coal)	Microsoft Teams or University of Venda	20 April
Geo-talk (Diamond Exploration)	Microsoft Teams or University of Venda	16 July
Geological excursions	Microsoft Teams or University of Venda	25 August
Mine visits	To be announced	15 September
Geo-vibe day	Phiphidi waterfalls	November

For further information on any of these events, please contact ***Nduvho Mulaudzi*** *(Branch Chairperson) at mulaudzinduvho9@gmail.com.*



Vista looking north at the folded quartzites of Timeball Hill Formation that forms the innermost layer of the majestic Katkloof anticline on the north-eastern margin of the BIC.

Young Geoscience Professionals Division

We are a new division of the GSSA dedicated to connecting and supporting young GSSA members (< 35 years old) including students and young industry professionals. Our goal is to help geoscience members negotiate unique challenges faced as young professionals. We also aim to highlight and promote the interests of young professional members in the GSSA.

Our mission:

- To foster networking and boost connectivity among young members.
- To help introduce the GSSA to students working towards and aspiring to be geoscience professionals.
- To highlight the benefits of being a GSSA member.
- To promote informative GSSA content to help smooth the transition from academia to industry.
- To promote formal and informal mentorship programs among young geoscientists.
- To help foster a sense of community among young geoscientists.

If you are passionate about geosciences as a student or young industry professional, then we are the division for you! Let us know what you would like to see in the GSSA as a young geoscience professional. Feel free to contact us at info@gssa.org.za.

Robyn Ormond

Western Cape Branch

Geodyssey, the mobile app: Putting the geology of South Africa in the palm of your hand

Speak to any South African geoscientist and they can (and most certainly will, enthusiastically) chew your ears off for hours about the bountiful and important geological heritage of our country. This can be done in a variety of "geological dialects'' based on the said geoscientist's interests or specialisation and can range from its mineral and mining wealth, palaeontology, landscapes, historical pioneers of geoscience, favourite sites to eat a sarmie or a sundowner at, and the list goes on. If by chance you weren't aware, the geology of South Africa is important and truly unique. It's "kind of a big thing" I tell my family and (few) non-geoscientist friends after I disappointingly conclude my lyrical waxing (or stark raving madness) for the umpteenth time at the importance of a particular geosite. Of course it always looks like an innocuous, or on the off-chance a "pretty", rock outcrop to them and never the transgressive shoreface deposit with fossils so delicately preserved that one "can see" the 400-million-year old sea floor (come on, mom…). I am a bad tour-guide…

What I so passionately struggle at doing, and I know I am not alone, is to convey just how abundantly blessed we are to have rocks in our backyard that speak to a unique and nearly unbroken 3.6 Gyr-long story of Earth history from a uniquely and proudly South African perspective. Depending where you are in South Africa, you could be standing on among the earliest continental crust in the Johannesburg Dome, be caught up in the root of an ancient orogenic front in the Limpopo Belt, wading among the earliest microbial platforms, reefs and tidal flats in Barberton and Pongola, or staring down your very ancient pre-mammalian ancestors (where did we go wrong…) in the Karoo, or having ring-side seats to watch the literal dawn of humanity take place in the Cradle of Humankind. Other than these scientifically important sites, there are those that are just breath-taking marvels sculpted by eons of geological processes: Table Mountain, Cederberg, Oribi Gorge, Hole in the Wall, Augrabies Falls, to name just a few. The role of mining in South Africa, for better or worse, is insurmountable in the foundation of industry, the development of our economy and of the many cities and towns that literally grew up around these sites of mineral extraction, metallurgy and beneficiation. These too are geosites that speak to

our geological heritage. Barberton, Johannesburg, the Witwatersrand, Kimberley, Hotazel, Okiep, Vanderbijlpark, the East Rand, all owe their success directly to the backbone of mining and industry in the modern day. At the same time, archaeological sites like Mapungubwe, Thulamela, Phalaborwa too speak to a deep-seated pre-colonial knowledge of South Africa's natural mineral wealth for millennia. Shucks, I haven't even mentioned Vredefort! The largest (and oldest, like *properly* old) asteroid impact exposed at Earth's surface! I mean, come on, that alone can't be topped! There is a reason why there isn't a geological edition of Top Trumps! South Africa simply holds all the cards.

To the uninitiated it must seem rather odd (comical more likely) to see geologists professing their teary-eyed admiration for "rocks". An outsider looking in probably sees a bunch of dishevelled, poorly dressed people standing at an outcrop of rock (beer in hand, notebook in the other, camera around the neck, hammer holstered) ranting and raving about something in that rock that speaks so deeply to them. I guess the natural reaction of an outsider might be something along the lines of "these guys must be mad…". Rocks literally speak to us and the stories they tell "ground us" (pun intended) in some way by giving us a connection and understanding with the Earth and (by extension) the Universe. What we don't understand is that we are useless storytellers who can't convey just how wonderful and fortunate we are to be alive and in a country like South Africa.

And in this time of being alive we now have access to modern technology to help us to do just that! We at the GSSA Western Cape Branch in conjunction with the Western Cape geoscience community and a local mobile app developer, Forge SA, have developed *Geodyssey*, a geoheritage mobile app freely available on both iOS and Android. The app works in an ESRI-driven ecosystem, meaning that it can display any data provided that it is georeferenced. Further to this, these data can be linked to georelational databases and hyperlinks and thus multiple datasets and maps can be displayed and queried in the app. *Geodyssey* can also be displayed as an interactive webmap, as on the GSSA Western Cape branch website: https://www.gssawc.org.za/education. Starting with the Western Cape, geosites of interest (viewpoints, outcrops, mountain passes, old mines, museums, geosites) have been identified and geospatially referenced. Each geosite has its own linked attribute field containing information pertaining to its name, how it formed, and its importance (among others) in the simplest of language. In addition to this, these geosites have other hyperlinked data in the guise of pictures, pamphlets, and publications. These geosites are displayed against the backdrop of an interactive 1:1 million geological map of the province. The geodatabase of the map has been modified to display the name of each geological unit, its lithologies, age, means of formation, and fun facts. Again, this has been done by using the simplest of language and cutting out as much jargon as possible (there's a built-in glossary to help with that). The true power of this platform is that any data can be linked and displayed to this platform, provided it is geospatially referenced with a linked geodatabase. For instance, as a built-in functionality of the app are the Forge SA hiking trail databases, allowing for you the user to know exactly what rocks you are on during your hike and, in some ways, to create your own geological adventure! The possibilities of linking any geoscientific data to the app are endless! Our hope is that the app can be used as a basis to promote South African geoscience education and outreach at any time and anywhere in the country. In time the uninitiated might be encouraged to see rocks the same way that we do and, perhaps more importantly, feel the same way that we do about our uniquely South African geology!

With time, and the participation of the greater South African geoscience community, we wish to expand the app to include adjoining provinces. We call upon you to assist us in expanding our geological and geosite footprint around the country. This can

be by championing the population of geodatabases or nominating provincial geosites. For more on the *Geodyssey* app, please make sure to tune into the upcoming GSSA Geoheritage conference!

We thank the 35 IGC and the GSSA for providing seed funding for the first version of this app and the Western Cape geoscience community for their input.

Cameron Penn-Clarke *and* ***Wendy Taylor***

hot pot

The Geological Hot Pot

There are many websites on the internet that report on the latest scientific discoveries that cater to the informed layperson. The writers of the articles attempt to minimise the technical language and jargon that scientists use, and this results in the findings being more interesting to the general public. Good science communication informs the taxpayer how their money is being spent in the case of government-funded research around the world. The BBC has science reporters that are very good, and *Nature* and *New Scientist* issue daily articles that are understandable to the everyman. The *SciTechDaily* website (www.scitechdaily.com) is recommended for those who are interested in a range of scientific topics, and I've found some of the articles below from the site.

If you can imagine giant mountain ranges with peaks as high or higher than those in the Himalayan Range (which is about 2 400 km in length), and that stretch well over 8 000 km, then you are looking at the two that formed during two periods of supercontinent formation on Earth. The first formed between 1 800 and 2 000 million years ago, giving rise to the Nuna Supermountains. The second resulted from the Gondwana Supercontinent that amalgamated between 500 and 650 million years ago. These extremely high

Folded rocks in the Damara Orogen that formed a segment of the Gondwana supercontinent (Ugab River, Namibia).

mountain ranges were subjected to rapid erosion, and the released nutrients had a profound effect on the development of life on Earth. You can read more about this fascinating topic at SciTechDaily, where there is also a link to the Open Access scientific article.

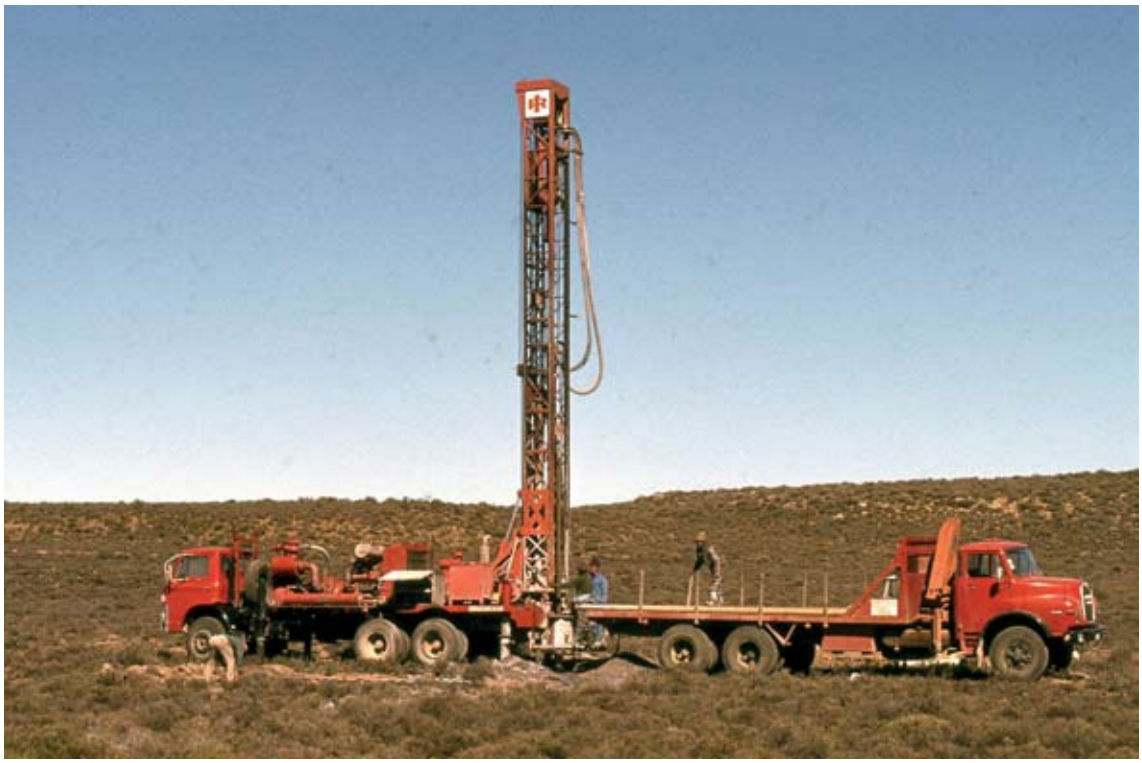
For those of you who have been lucky enough to view the Grand Canyon, there is a geological puzzle in plain sight that has fascinated scientists for a long time. It is the "Great Unconformity" that separates folded and deformed Precambrian rocks that are overlain by mostly flat-lying Palaeozoic rocks. Recent geological studies on the cause of this unconformity have narrowed this down to two main theories, although there are several others. One is that the erosion is related to the assembly and breakup of the Supercontinent Rodinia between 1 000 and 550 million years ago, involving a protracted plate tectonic cycle. The other suggests that the Precambrian rocks were carved away by ancient glaciers when the Earth underwent a period of very cold conditions from about 700 to 635 million years ago. This icy period has been termed "Snowball Earth", another topic that has attracted world-wide research. Thermochronologic studies conducted by a group of geoscientists, including two from Dartmouth College in the USA, lend support to the glaciation idea. This research, reported in SciTechDaily, ties in neatly with the Supermountain concept, because erosion by glaciers is highly effective.

The South Rim of the Grand Canyon in Arizona. The Great Unconformity is exposed in places by the incision of the Colorado River through the section.

From Supermountains to microscopic and mini life. This article, which first appeared in *Knowable Magazine* and was republished by the BBC, gives an intriguing insight into the busy world immediately under our feet. Researchers in the new field of soil bioacoustics are studying the surprisingly abundant life forms in soils that we as yet, know very little about. To quote from the article: "In just a cup of dirt, researchers have counted up to 100 million life forms, from more than 5,000 taxa. Underground denizens range from microscopic bacteria and fungi, pencil-dot-sized springtails and mites, to centipedes, slugs and earthworms that can reach several metres in length. They are joined by moles, mice and rabbits that live at least some of their lives in underground tunnels and dens." This amount of biodiversity does make a lot of noise, and this is what the ongoing research is studying. The article is well illustrated and most informative.

Exploration for minerals has always been vital for the progress of humankind. From simply looking for the right rock to fashion stone tools by our ancestors, to prospecting for outcrops of ore-bearing rock to supply the important materials for our industrial age,

Two granitic lonestones in diamictite, interpreted as glacial in origin, from the Chuos Formation of the Damara Sequence in Kaokoland, Namibia. The Chuos Formation was deposited during the Snowball Earth era.



Percussion drilling rig exploration for sandstone-hosted uranium deposits in the Great Karoo near Sutherland in the Northern Cape.

we've not stopped looking. Now that the relatively easy-to-find ore deposits are known, innovative techniques are necessary to search for and to find hidden, mostly deep within the Earth, deposits. A *Mining Review* article mentions some of these innovations that impact on mining exploration. Global position systems, satellite imagery, novel processing software applied to old geophysical and geochemical data and artificial intelligence, among others, are being applied to increase the chances of discovery of significant ore deposits. However, for the good of our profession, a geoscientist will always be necessary to do the fieldwork, and verify or discard any potential mineral "discoveries".

Many of us geoscientists are involved in the search for economic mineral deposits that are critical for modern human existence. Some important elements such as copper, nickel and gold have their source in the Earth's mantle and are carried

Native gold specimen 5-6 cm across from the Sun Yet Sen Mine in Zimbabwe. Specimen housed in the Bulawayo Museum. Sun Yet Sen was the first President of the Republic of China when the Qing Dynasty ended in 1912. It would be interesting to find out how and why the mine was named after him.

upwards in magma. The mechanism by which these economic element-enriched magmas reach the surface through the crust has been unknown until a recent study published in *Nature Communications*. It transpires that there is a temperature-dependent zone at the base of the crust where the rising magma is not trapped, but instead escapes upwards through the crust. This "Goldilocks zone" is explained in the SciTechDaily article.

Being now retired and of a certain age, I found this article about diet and life expectancy rather intriguing. As I anticipated before reading the article, however, the optimising of your diet is very much more beneficial for younger folk and is only marginal for the older generation. Nevertheless, every additional day in our lives is a blessing, and we should all eat healthily in any case.

George Henry

ICDP research drilling

ICDP research drilling in the Moodies Group of the Barberton Greenstone Belt is underway

ICDP (International Continental Drilling Program) research drilling in the Moodies Group of the Barberton Greenstone Belt (BGB) started in mid-November 2021 and will continue into May 2022. The Moodies strata are about 3.22 billion years old and up to 3.7 km thick. They record surface processes in very well preserved and correlatable fluvial-to-prodeltaic siliciclastic rocks at an extremely high resolution. The overall depositional rate of ~1 km/Myr is approximately comparable to mean depositional rates at modern passive-margin coastlines.

Despite tight regional folding, the metamorphic grade of the Moodies Group strata is only lower-greenschist facies. There is a nearly complete absence of penetrative strain because many beds were cemented early-diagenetically, in particular in the hydrothermal halo of the Lomati River Sill

Site 2 is set up next to the parking bay (visible in the background) along the R40 Geotrail, which winds its way across the central Barberton-Makhonjwa Mountains. The fenced site measures only 15×15 m in diameter. The rig drills at a 45° angle through steeply inclined strata of the Dycedale Syncline at about 15–20 m/day.

School classes, delegations, local residents and tourists visit the exhibition. Here, Ms. Phumelele Mashele explains slabbed core to 8th grade learners from a local high school.

in the central BGB. This has preserved abundant primary micro- and macrotextures. Geological mapping has documented palaeosols, terrestrial evaporites, potentially aeolian strata, shoreline systems, tidal microbial mats, deltaic complexes, and marine ferruginous sediments or banded iron formations. Collectively, the Moodies strata provide a worldwide unique opportunity to reconstruct early bio-geo-atmo-hydrosphere processes and conditions, particularly those related to diverse and well-documented microbial life.

The high relief of the Barberton-Makhonjwa Mountains makes for locally excellent outcrops

In the targeted sections, Moodies strata show virtually no strain and are excellently preserved. They show commonly spectacular sedimentary structures in a variety of rocks types, including sandstones, tuffs, conglomerates, and subordinate shales and BIFs.

BASE temporarily uses part of a large former industrial hall in the centre of Barberton. The front section (foreground) is used to showcase the geology of the Barberton Greenstone Belt, the objectives and locations of the drilling program, and its relevance for the World Heritage Site. Core processing (background) can be observed by the visitors up-close.

that allow the prediction of subsurface geology to some degree. However, the effects of oxidative weathering run deep. Eight inclined diamond drill core holes in the Saddleback Syncline, the Eureka Syncline and the Stolzburg Syncline of the central BGB, each 350–450 m in length, are planned, to obtain continuous sections suitable for geochemical and time-series analyses.

Drilling aims at coring selected stratigraphic intervals that show diverse and structurally undisturbed siliciclastic facies transitions, associated with lava flows, tuffs, primitive soils and vadose-zones, prodelta rhythmites, jaspilites and BIFs, and/or microbial-mat sandstones. In selecting the sites, the science team placed particular emphasis on avoiding hydrothermally mineralised zones. At the time of writing (March 8, 2022), two fully cored boreholes of 280 and 340 m length, respectively, are completed. Three rigs are currently operating: two of them investigate the middle and the proximal facies of the Lomati Delta Complex of the Saddleback Syncline; the third rig will likely complete a 350 m section through a lithologically highly variable terrestrial–tidal transition with common microbial mats in the Dycedale Syncline. Drilling operations are set to end in mid-May after drilling sections in the Stolzburg and Eureka Synclines.

A central objective in this drilling project is to investigate the evolutionary development of oxygenic photosynthesis because it was and is responsible for the profound transformation of surface environments; it allowed the rise of eukaryotic and complex multicellular life. Various geochemical clues suggest that there were at least temporary variations in the overall very low level of atmospheric oxygen by ~3 Ga. This is consistent with results of recent molecular clock analyses that suggest the onset of oxygenic photosynthesis prior to that time, probably via microbial consortia including highly productive benthic cyanobacteria that colonised early shorelines. Other research objectives will address the setting of the thin BIFs and jaspilites found in the fine-grained sections, the weathering conditions inferred from palaeosols and lava flows, and Moon–Earth dynamics, represented in sandstone tidal bundles and siltstone-shale prodelta rhythmites.

The project is about eight years in the making and is partially based on geological mapping and studies by Christoph Heubeck, Friedrich-Schiller of the University Jena, Germany, and his students. ICDP initially funded a field workshop in 2017 during which ca. 50 international participants inspected potential sections and formed working groups. ICDP funding, covering about 50% of the

Site 3 (foreground) of the BASE (Barberton Archean Surface Environments) drilling project recovered 340 m core from steeply dipping, overturned strata of the Saddleback Syncline, central Barberton Greenstone Belt. This included ca. 200 m of microbially laminated sandstones of tidal-flat facies.

total costs of ca. ZAR 25 million, was successfully obtained in 2019. Co-funding came in from the US, Belgium, Germany, South Africa, Japan, Norway, Switzerland and DSI-NRF CIMERA; research proposals aiming to contribute to drilling and follow-up expenses from several other countries are still pending. The project is administered in South Africa by DSI-NRF CIMERA at the University of Johannesburg. After the end of the drilling campaign, the archive half of the cores will be stored at the National Core Library at Donkerhoek near Pretoria; the working half of the cores will be shipped to ICDP core analysis and storage facilities in Spandau, near Berlin, Germany. A "sampling party" is tentatively scheduled for the end of this year.

Core processing is currently taking place in the BIAS Hall next to the Barberton Museum in downtown Barberton. Our setup is open to the public and includes an exhibition on the geology of the BGB, polished rock samples, geologic maps, and posters illustrating the value of geologic research in general and for the recently (2018) declared Barberton-Makhonjwa Mountains UNESCO World Heritage Site, which encompasses a large part of the central BGB. A core point of the exhibition is to demonstrate that the value of the World Heritage Site was created and will be maintained by continuous and unhindered geological research.

Follow our daily updates and biweekly newsletter at the ICDP project link or the Moodies-BASE Project Facebook page.

For more information:
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***Christoph Heubeck**, **Nic Beukes** and the BASE Onsite Geoscience Team (**Dora Paprika, Phumelele Mashele, Chris Rippon, Ryan Tucker, Rodney Tucker, Tony Ferrar, Astrid Christianson**)*

mineral scene

Baddeleyite – Palabora mine, South Africa

As large, free-standing crystals, baddeleyite (ZrO_2) is relatively rare, but it is found as tiny grains in many localities worldwide, primarily in mafic rocks, although it can be a minor component in heavy mineral sands. It also occurs in carbonatites and some meteorites. Baddeleyite crystallises in the monoclinic system, forming various coloured crystals, from colourless to yellow, green, brown or black. It has a vitreous to greasy lustre, hardness of 6.5, and specific gravity of 5.4 to 6.02. Because it is typically enriched in uranium, baddeleyite has been used extensively for U-Pb geochronology.[1,2]

Baddeleyite was first described in the late 19th century by Fletcher,[3] based on samples he received from Sri Lanka, from Joseph Baddeley after whom the species was named. Baddeley was a British geologist working in Sri Lanka (Ceylon) at the time. He was supervising a railroad project and sent samples of what he considered unusual minerals to the Museum of Practical Geology in London for identification. This resulted in the discovery of geikielite ($MgTiO_3$). Subsequent to this he sent more samples and this led to the discovery of the ZrO_2 species named then in his honour.

Two highly striated, lustrous baddeleyite crystals in foskorite matrix. The larger crystal is 2.1 cm. (Specimen and photo: Bruce Cairncross)

A 10 cm terminated baddeleyite crystal. This specimen is the finest known for the species. (Specimen: Desmond Sacco; photo: Bruce Cairncross)

Although sizable, free-standing baddeleyite crystals up to a few cm are known from the Mandalay Region in Myanmar, most other localities produce smaller crystals. Without doubt, the largest crystals known come from the Palabora mine in the Limpopo Province, South Africa.[4] The crystals occur in the Loolekop ore body in foskorite and carbonatite host rock. Hiemstra[5(p276)] in an early study of Palabora baddeleyite noted that it "… occurs typically in the form of short black prismatic crystals, mostly between 0.05 and 1 mm in their longest dimension… Untwinned crystals are rare".

The majority of baddeleyite occurs as small, less than one millimetre crystals. However, compared to other localities, some Palabora baddeleyite is extraordinarily large and although they are often imbedded in matrix, they can be chemically and mechanical freed of surrounding rock to produce aesthetic specimens such as the two examples shown here.

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GSSA events 2022

January 2022 – November 2022

2022 will be a combination of virtual, physical and hybrid events.
The GSSA reserves the right to make changes to the calendar.

DATE	EVENT
8 February - 1 March (4 x ½ days) + self-study	Drilling Methods and Techniques in Resource Exploration
15 March	CPD Workshop
3 - 7 April	Geoheritage Conference
10 - 12 May	Diamond Course
20 - 22 May	Advanced Structural Geology/Field Trip
15 June	Energy Day
7 - 8 July	Minrom Geological Maps: field data to making maps and GIS
6 - 9 September (4 x 1 day)	Minrom Project Management for Geologists
13 September - 4 October (4 x ½ days) + self-study	Drilling Methods and Techniques in Resource Exploration
7 October	3-D Geological modelling
8 November	ESG Inquisition Feedback
17 - 18 November	Technology and African Exploration Showcase

obituary

Andries Adriaan (Billie) Bisschoff †

Andries Adriaan (Billie) Bisschoff
11 May 1922 to 13 January 2022

On 13 January 2022, 118 days before his 100th birthday, Andries Adriaan Bisschoff passed away of Covid-19-related complications. His wife, Patricia Bisschoff, also succumbed to Covid-19 complications the previous day.

Andries Bisschoff was known to family, friends, colleagues and acquaintances as Billie or Andries. Students and other colleagues named him Prof or Prof Bul. I called him Pa. Out of respect, I will refer to him throughout this tribute as Prof Billie.

Andries Adriaan Bisschoff (1992)

A tribute to the life and times of Andries Adriaan Bisschoff (1922–2022)

Andries Adriaan Bisschoff was born on 11 May 1922 on the farm Rustvoorbij, district Swartruggens in the North-West Province, South Africa. Early farm life did not only create a lifelong love for nature, but it also developed his inquisitive mind. It kindled his creative spirit. These were the years of the Great Depression, money was scarce, and "'n boer moes 'n plan maak" (Afrikaans saying, meaning if you have limited means, you have to innovate). After attending farm school up to Standard 6, he matriculated in 1940 at the Rodeon Hoërskool, Swartruggens. The motto of this school, "Wees opreg" (free translation: be sincere), was something that he cherished, and pursued throughout his life. This characteristic earned him the nickname of Prof Bul under students—he had a no-nonsense approach, but you knew exactly where you stood with him. He was somebody that made an effort to be sincere with all people he came in contact with.

In 1941 Prof Billie registered for a BSc degree at the Potchefstroom University for Christian Higher Education (PUK). The Geography and Geology Department was created as one department in 1935, with Mr J.S. van der Merwe as a Geography lecturer, with Geology as a co-responsibility. In 1940, under Mr P.B. Ackerman, the first dedicated Geology lecturer at the Potchefstroom University, the first seven students graduated with Geology as a major subject. Prof Billie graduated in 1943 with Geology and Chemistry as major subjects, as part of the fourth group of geologists educated at the Potchefstroom University.

Due to financial constraints, Prof Billie had to work before he could continue with his studies. During 1944 he was employed by the South African Crayon Co. in Potchefstroom. His major tasks were troubleshooting and process improvement. He quickly determined that the kaolin material used had a high proportion of sand, and by simply increasing the milling time, and sieving the material, a better end product was obtained.

In the beginning of 1945, Prof Billie accepted a junior lecturer position in Geology at the Geography and Geology Department at the Potchefstroom University. Thus, a 42-year-long career in the

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Top: Geology wing of the geography building, 1938–1947.

Middle: Plane-table mapping in the vicinity of the Potchefstroom Military Cemetery, 1943. Prof Billie is second from the right.

Bottom: Geology and Geography excursion to the Vredefort Dome, 1943. Prof Billie is the one with the pipe on the passenger-side mudguard of the vehicle.

Potchefstroom University Geology Department commenced on 1 Feb 1945.

In 1947 Geology became an independent department, with Prof Piet Ackerman and Prof Billie being the only two lecturers. They moved to a separate building next to Geography. This was the home of Geology until 1971, when they moved to the new J.S. van der Merwe building (this building was named after Prof Jan van der Merwe, the first HOD of the combined Geography and Geology Department).

Piet Ackerman and Andries Bisschoff essentially had to build a Geology Department from scratch, with very limited resources, financially and otherwise. Lecturing material had to be compiled and standardised, laboratory equipment, mineralogical and petrographic microscopes obtained, and thin section preparation facilities had to be established. For the first 18 years they were the only academic staff, and the emphasis was on lecturing and training—from first year to post-graduate. Throughout his career, one of Prof Billie's passions was the collection of rock and mineral specimens for practical work, as well as the establishment of a Geology Museum. As the Vredefort Dome with its variety of rocks is located fairly close to Potchefstroom, it was the ideal place to collect specimens. Another opportunity to expand the collection in the museum was during the annual field excursions. Students visited places of geological interest in South Africa and neighbouring countries during university holidays, and specimens were added to the museum. These excursions were frequently led by Prof Billie.

Especially in later years, when he was recognised as one of the experts on the Vredefort Dome, Prof Billie led numerous local and international fieldtrips to the Vredefort Dome. This continued until he was well into his eighties, and even early nineties.

Especially in the beginning years of the Potchefstroom University Geology Department, research time was restricted to holidays. In

Top left: 1978 Third Year and Hons field trip to Namaqualand. Prof Billie is standing. The departmental vehicle, a converted lorry, was known as the Gallopie.
Top right: 1984 Field trip to Pilanesberg. Prof Billie is in the middle of the second row.
Bottom Left: Probus Field Trip, about 2004. Prof Billie is 5th from left. Also note Martin Brink on the extreme left.
Bottom Right: Ludwig Maximilian University Vredefort visit, date uncertain, somewhere in the 1970s. Prof D.D. Klemm is 5th from left; Prof A.A. Bisschoff is 7th from left, back row.

1948 Prof Billie Bisschoff was the first student at Potchefstroom University to complete a BSc (Hons) degree in Geology. In 1949 he achieved an MSc (cum laude) with a dissertation on the Roodekraal Complex, located about 12 km south of Potchefstroom. He cycled to Roodekraal in the mornings, did his fieldwork, and returned at sundown. His mapping equipment and samples were transported by bicycle. For his MSc petrographic studies, he had to make his own thin sections. In 1953 he was promoted to Lecturer, and in 1958 to Senior Lecturer.

The Vredefort Dome is also ideally located for mapping and research from Potchefstroom. Prof Billie held the mapping of the Vredefort area by L.T. Nel in 1923–1925 in high esteem, and remarked to me once that one can only improve on it by adding detail. In a certain sense, this is the tendency in modern geology as well—technology today allows analysis in detail that was unthinkable 50 years or so ago.

During the 1950s and 1960s larger scale remapping of the Vredefort Dome commenced. Prof Billie started on the Westrand Subgroup and associated rocks, from the Fochville side up to Schoemansdrif, as well as the Rietfontein Complex. By the mid 60s, he had mapped about 200 km^2, and distinguished between 80 and 90 units. After he completed his petrographic studies and other laboratory work, he submitted his DSc thesis "*The petrology of the igneous and the metamorphic rocks in the Vredefort Dome and the adjoining parts of the Potchefstroom Syncline"* at the University of Pretoria. He was awarded the DSc degree (unofficially, cum laude) in 1969. From this work a number of publications in scientific journals flowed.

UNISA presented some science subjects, such as Geology, Botany, Zoology, Microbiology and Physiology at undergraduate level since the 1950s. An agreement between UNISA and the PUK was reached that the PUK would handle the correspondence courses and practical training (at the Potch Campus) on behalf of UNISA. Prof Billie was responsible for this until his retirement in 1987.

In 1974 he was promoted to Professor, and in 1976 he became Head of the Department of Geology. Although most of his time was devoted to running the department, he still lectured Igneous and Metamorphic Petrology and supervised a

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DSc Graduation, University of Pretoria, 1969. Andries and Albie Bisschoff.

number of post-graduate students, some of them working on the Dome. His involvement in the Vredefort Dome research continued, and in 1987, the year in which he retired, the Potchefstroom University Geology Department co-organised the "International Workshop on Crypto explosions and Catastrophes" held in Parys.

After retirement, Prof Billie was still involved in the activities of the Geology Department. A lifelong goal of Prof Billie and his Department to re-map the Vredefort Structure on a larger scale was realised in 1993. The new Vredefort Geology Map was handed over to Dr C.J. Van Vuuren, Director of the then Geological Survey of South Africa.

Prof Billie was immensely saddened by the Potchefstroom University authorities' decision to adhere to the Committee of University Heads' recommendation to phase out Geology as a major subject since 1992. However, he found solace in continued contact with many of his alumni. For many he was not only a tutor, a mentor, but also a friend. He was frequently visited by his alumni when they travelled through Potch. When he and I once discussed syllabi, he commented that the primary function of a university is to teach people how to think, and not to only master techniques. In this way, one would be able to solve problems outside normal situations. This approach worked well, and many PUK alumni reached the highest rung in industry.

About 10 years later, the university decided to reinstate geology as a major subject.

Towards the end of the previous millennium, Prof Billie and two of his alumni, Dr Martin Brink and Prof Frans Waanders, got involved in the process to have the Vredefort Dome declared a UNESCO world heritage site. Their work greatly contributed to the

Class of '41, 50 years later.
Back: Prof Billie, Dr Chris Potgieter.
Front: Abe Kruger, Miempie de Kock (Née Scheepers).

Left to right: Bevan and Mary-Hill French, Frans and Petro Waanders, Annatjie Brink, Billie and Patricia Bisschoff, Martin Brink.

declaration in 2005. During 1999, Prof Billie, Martin and Frans hosted Bevan French from NASA and the Smithsonian Institution, one of Prof Billie's lifelong associates, on a visit to South Africa.

In 2004 the Potchefstroom University for CHE decided to honour Prof Billie by naming their geology museum after him: the Andries Bisschoff Geologie Museum. This was in recognition of his contribution to the establishment of the Geology Department, his research on the Vredefort Dome, the expansion of geology in South Africa and the legacy of a comprehensive rock specimen collection in the museum.

Prof Billie became a member of the Geological Society of South Africa in 1948, and a member of the Council in 1974. He was president of the Society for 1981/1982. In 1984 he became a Fellow, and in 1989 an Honorary Member. During his presidency, the Geological Society played a leading role in the establishment of the South African Council for Natural Science Professions (SACNASP). A special moment for my dad and I occurred during a 1997 Council meeting. He attended the meeting as a past president, and I as a representative of the Free State Branch. Rod Tucker, that year's president, commented that it probably was the first time in the history of the Society that both a father and

GSSA Council 1980/81. (Source: Tukkie-werf, 1981, No. 4)

☞

All things igneous: Prof Billie in discussion with Profs G. Von Gruenewalt(UP), H.T. Papunen (Finland) and K. von Gehlen (Germany) at Geocongress '81, Pretoria.

son served on the Council. Prof Billie's membership of seventy-three years gives new meaning to the category of life-long member! It must be some kind of record!

Prof Billie had a phenomenal memory. During November 2021 we were discussing quartzite close to the contact between the Pretoria and Chuniespoort Groups in the Carletonville area. With a smile he recalled a thin quartzite layer outcropping close to the Driefontein Golf Club. We consulted his "Red Book" (Stratigraphy of South Africa). There, in his neat handwriting, on the strat column next to page 205, he wrote "Pologround Formation"—this note was made about 35 years earlier!

Prof Billie was a family man. He was married to Albie van der Walt in 1950. They had two sons, Danie and Ignatius. Albie passed away in 1975 at the young age of 49 years. In 1985 Prof Billie remarried. Patricia

Prof Billie doing what he enjoyed most: being in the veld, showing people the geology of the Vredefort Dome.

Even as an elderly man, Prof Billie enjoyed reading from his vast library of geological and other scientific literature. One of his pet subjects was water dowsing.

Jacobs (née Pullen) was his spouse for the next 37 years. She fell victim to Covid-19 a day before him. He had four biological grandchildren, and five more grandchildren and five great-grandchildren from Patricia's side.

Geology was not the only passion he pursued. He was very compassionate, and did a lot of charity work in the Potchefstroom community. His first wife, Albie, was the first headmistress of the ES La Grange School for severely mentally handicapped children. She and Prof Billie recognised the need for the care of these children as adults. After her early passing, he pursued this goal passionately, and was one of the founding members of the Amelia Nasorg Sentrum in Potchefstroom. He and his second spouse, Patricia, were still actively involved in the activities of Amelia at the time of their passing. They were also members of the SPCA. Another lifelong passion was the opera and Schubert Lieder.

Prof Billie did a lot of consulting work in and out of Potchefstroom—for the municipality, his alumni, and close to anyone else that asked him. He never charged a penny. His philosophy was that he got a salary, if he could help somebody, it was reward enough for him.

Opening of the Andries Bisschoff Geologie Museum.
From left to right: Daan van Wyk, Marthie Coetzee, Andries Bisschoff (after whom the museum was named),
Huib van Hamburg (School Director at that time).
(Source: NWU Envira newsletter, autumn 2021 edition)

One of his favourite Shakespearian quotes was from Hamlet: "This above all: to thine own self be true, and it must follow, as the night the day, thou canst not then be false to any man." Prof Billie's interpretation of this quote was: Give of yourself without expecting anything in return. The merit of your toil will be your reward.

On 13 January 2022 the geological fraternity lost a giant. We salute him.

However, his legacy lives on. To me, he not only was a mentor and friend, but also a dad.

Ig Bisschoff

THE GEOTRAVELLER

By Roger N Scoon*

The Seychelles:

Granitic Ocean Islands, Coral Atolls and Endemism

The coastline of Mahé includes small bays at the foot of lush forested slopes.

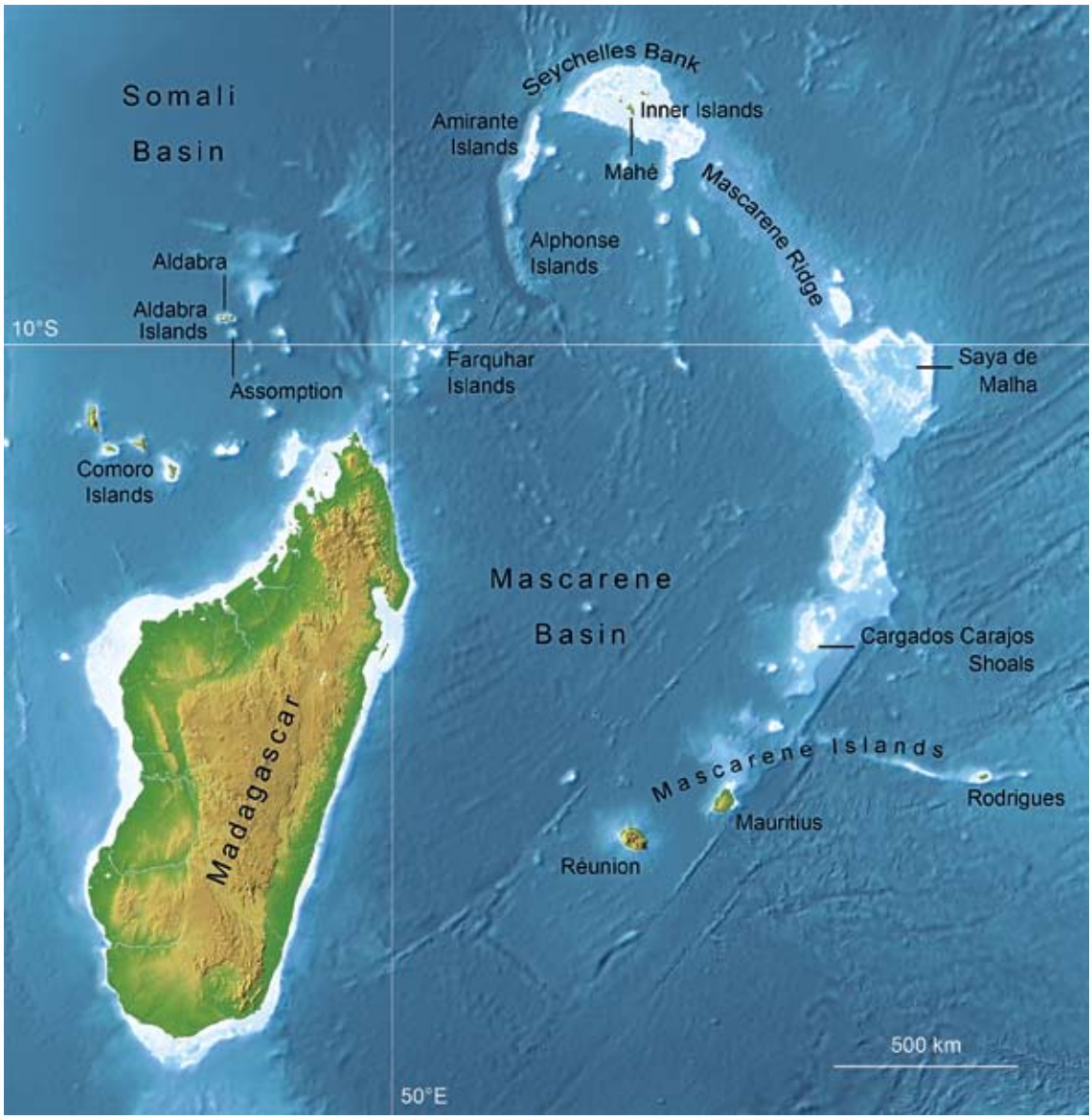
Clusters of granitic boulders are features of the beaches on Mahé.

Silhouette is one of two islands in the Inner Islands associated with volcanic rocks.

The Republic of the Seychelles is a diaspora of over 100 islands in the western Indian Ocean. Five discrete archipelagos are recognised (situated between 4°S and 10°S latitude), with a total land area of 455 km^2. The most important of the archipelagos is the "Inner Islands", a group of 46 islands and islets located on the shallow Seychelles Bank. The Inner Islands are primarily granitic and constitute the geologically oldest known oceanic islands. The three largest islands of Mahé, Praslin and La Digue are popular tourist destinations with fine, white sandy beaches and shallow tropical seas. The four archipelagos of the "Outer Islands"—Almirante, Alphonse, Farquhar and Aldabra—contain 72 coralline islands and coral atolls and are among the youngest islands in the Indian Ocean. The coral atolls cap submerged volcanic cones (which have long been extinct) where the ocean attains considerable depth.

The capital of the Republic of the Seychelles is Victoria, located on Mahé, the largest of the Inner Islands (area of 157.3 km^2). Despite being located 1,350 km from the east coast of Africa, the Seychelles is part of the African group of nations. Most visitors fly to Victoria. There is a local airport on Praslin, the second largest island (area of 38.5 km^2) and there are also airstrips on the Outer Islands, including Alphonse and Assomption. The Seychelles has a year-round hot and humid climate. The northwest monsoon is associated with a short rainy season (March–May); the southeast monsoon winds bring marginally cooler weather (May–September). The occurrence of two distinct seasons has been less evident in recent years, a factor ascribed to climate change. The islands lie outside of the cyclonic wind belt and high winds are extremely rare.

The Inner Islands were uninhabited prior to being discovered by European sailors in the 16th century. The earliest recorded sighting was by Portuguese navigators in 1503, with the British navy undertaking the first landing (on Mahé) in 1610. Many of the Outer Islands, however, were known to Persian and Arabic sailors long before the Europeans arrived. The French and British culture of the Seychelles reflects the various periods of colonial occupation. People from Africa, India, China and Europe settled during this period. The isolated location and absence of early humans has resulted in an unusual number of endemic species. As many as 75 endemic flowering plants and several hundred snails, insects and other invertebrates occur, together with 15 endemic bird species. Endemic species are protected in national parks. The coco de mer, a specialised

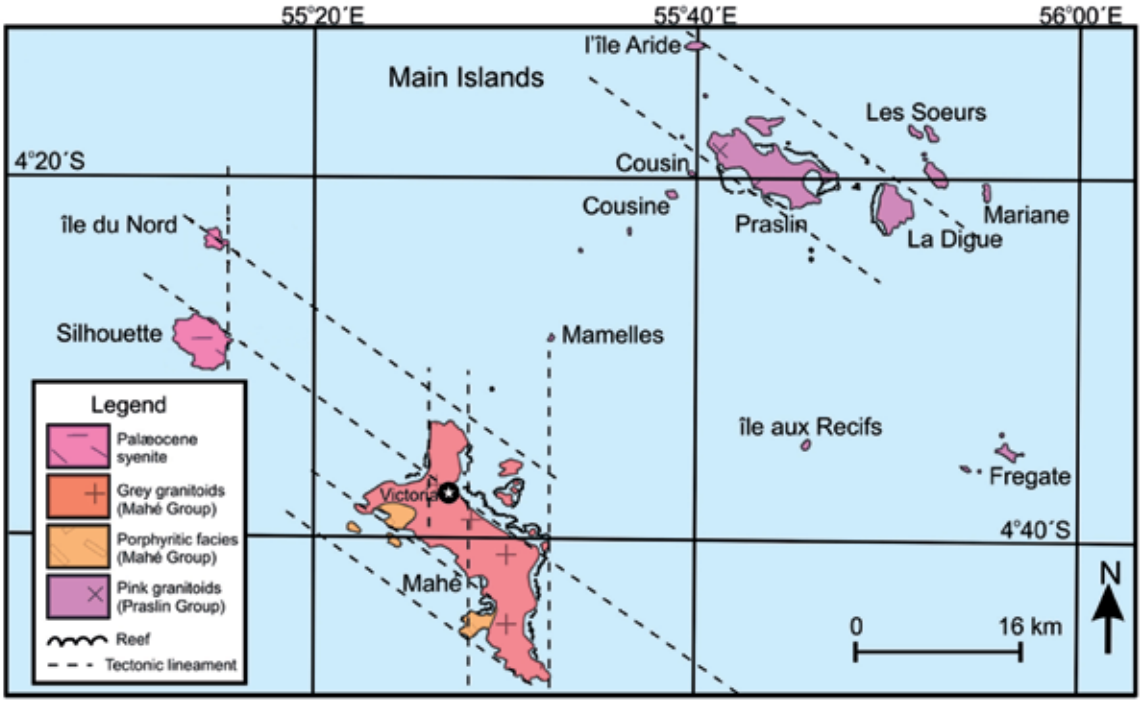


Satellite image of part of the western Indian Ocean showing the location of the Inner and Outer Islands of the Seychelles. The Seychelles Bank (white to pale blue) correlates with the granitic batholith; islands located in the deep ocean (dark blue) include coral atolls that cap volcanic seamounts. (Source: Planetary Visions, based on ETOPO2 bathymetry and topography from NOAA-NGDC)

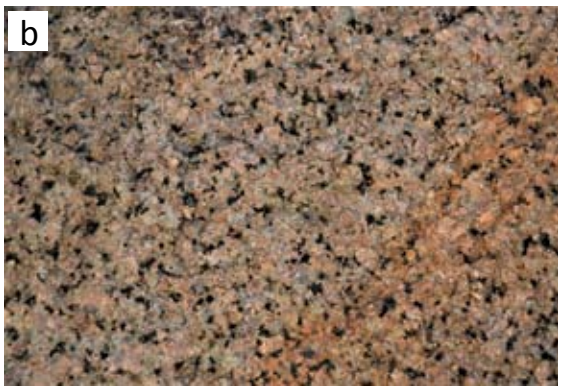
palm, is the most famous of the endemics and attracts large numbers of visitors. Endemic species of giant tortoise occur on many of the islands (they can be compared with the giant tortoise of the Galapagos Islands).

Inner Islands

The geological framework of the Inner Islands was investigated by Baker in 1963[1] as part of his association with the Geological Survey of Kenya. The principal geological feature of the Inner Islands is a granitic batholith that underlies the entire Seychelles Bank. The granitic islands are topographic highs. A coarsely crystalline, homogenous, grey granite is found on Mahé; a pink, porphyritic granite occurs on parts of Praslin and La Digue. The granite forms rounded hills with clusters of large boulders. Granitic boulders occur on the narrow coastal plains and beaches. Formation of boulders is related to exfoliation or onion-skin weathering. Tabular or finger-shaped boulders develop as large sections of the granite are jointed. Fluting of the granitic outcrops is a prominent feature resulting in intriguing outcrops on the beaches. Swarms of WNW–ESE-trending dolerite dykes cut the granite. Sedimentary rocks are a minor feature, although a Pleistocene limestone formed on the fringes when the islands were submerged by higher water stands. Two volcanic islands (Silhouette and Ile du Nord) and two coralline islands (Bird Island and Denis Island) are recognised in the Inner Islands. The latter are flat sand cays (maximum elevation of a few metres) comprising uplifted reefs with eroded and wind-blown fragments of coral.

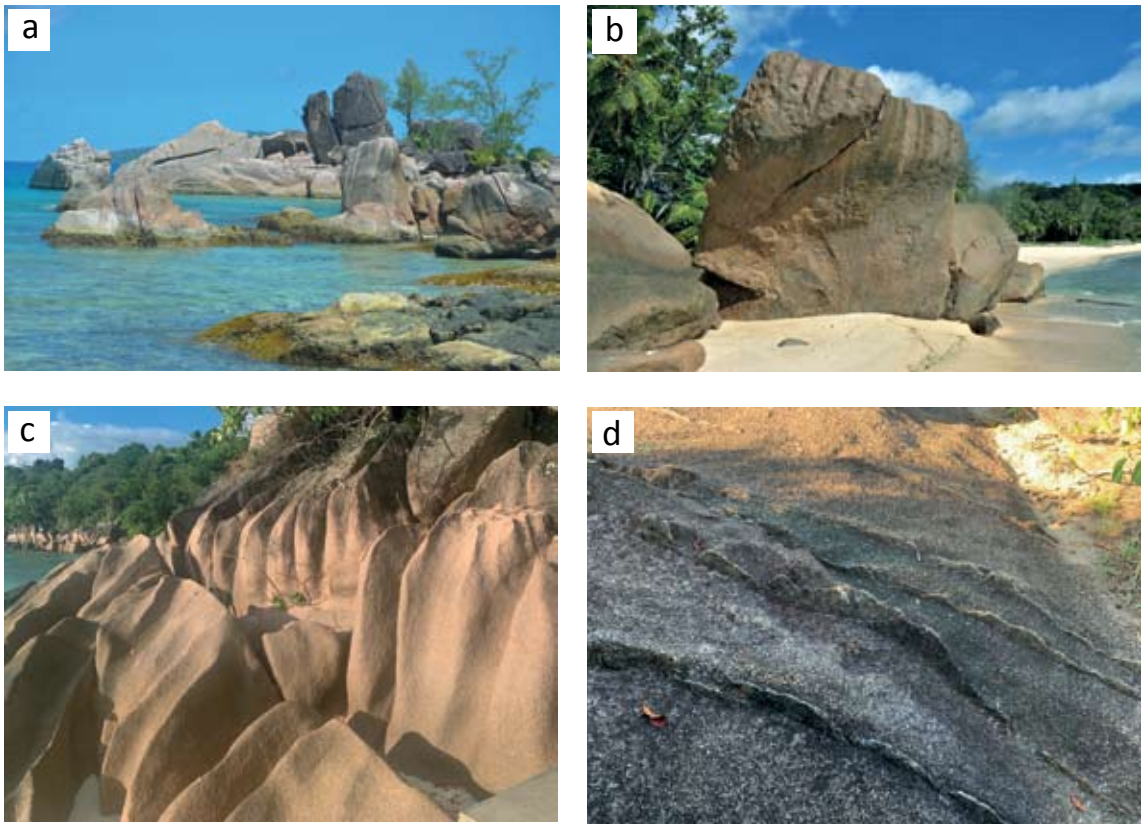


Geological map of the Inner Islands.[9]



The granite outcrops include
(a) grey granite, Mahé;
(b) red granite, Praslin;
(c) red granite with xenolith, La Digue;
(d) markedly resorbed xenolith in the red granite, La Digue.

The occurrence of a granitic basement beneath the Seychelles Bank was described in the early part of the 20th century by Alfred Wegener as evidence in support of his hypothesis of continental drift. The granite is part of the Seychelles Microcontinent and formed on the supercontinent of Gondwana during the Neoproterozoic.[2–6] Two broad phases of granitic magmatism are identified. The grey granite (710–680 Ma) is older than the pink, porphyritic granite (665 Ma). Some of the dolerite dykes are coeval with the granite; others are considerably younger (135 Ma). The younger dykes are related to the breakup of Gondwana, a long drawn-out series of events that probably commenced in the Lower Jurassic (at approximately 180 Ma).[7]



(a) Granite boulders reveal tabular or finger structures; (b) striated boulders of granite; (c) fluting in granite boulders; and (d) quartz veins in the granite.

Dolerite sill is overlain by red granite, Praslin.

The breakup of this part of Gondwana, which included the splitting of Antarctica–Australia and Madagascar–Seychelles–India, occurred at 120–85 Ma. The Somalia and Mascarene Basins are deep sections of the Indian Ocean that commenced forming in the Early Jurassic. A thick sequence of coarse-grained clastics accumulated in the basins.

In the Late Cretaceous to Early Cenozoic, India drifted northeast—on a transform fault—and by approximately 60 Ma the Seychelles Microcontinent, together with the Mascarene Plateau (which contains the islands of Mauritius and Reunion), were discrete features in the nascent Indian Ocean.[8] In the Early Cenozoic, these landmasses were eroded

and impacted by volcanic activity. This included formation of syenite (dated at 62.4–60.6 Ma) on the islands of Silhouette and Ile du Nord[9] as well as the seamounts (extinct) of the Outer Islands.

The shallow, warm seas of the Seychelles Bank (area of approximately 31,000 km^2 and average depth of 44–65 m) support fringing coral reefs around most of the Inner Islands.[10] The reefs constitute a continuous barrier on the eastern sides of the islands but are confined to narrow bays (due to wave action generated by the prevailing southwest winds) on the western sides. The growth of coral is supported by average seawater temperatures of 27–32°C. The recent and severe degradation of the reefs, including excessive bleaching, can be observed in intertidal zones. This is ascribed to increased water temperature related to northerly currents driven by the El Niño-Southern Oscillation (warming of surface waters in the eastern part of the Pacific Ocean).

The forested slopes in the hilly, northern part of Mahé include the highest point on the island. Morne Seychelles (905 m) includes a small national park that protects the mostly indigenous forest

(a) and (b) Wave-cut platform consisting of dead coral, Praslin.

La Misere viewpoint with the manmade Eden Island (Mahé) and the islands of Praslin and La Digue visible in the background.

and endemic species that include Gardiner's Seychelles frog (*Sechellophryne gardineri*), which has a length of only 11 mm, the Seychelles black snail (*Stylondonta*), the Seychelles tree fern, and many species of orchid. The endemic jellyfish tree (*Medusagyne oppositifolia*) is critically endangered. The La Misere viewpoint on the northern slopes of the mountain has views of the islands to the north and east of Mahé, e.g., Praslin, Cousine, La Digue and Fregate, as well as the manmade Eden Island. The Morne Blanc National Park includes a 1.6 km-long nature trail (630 m range in elevation). The viewpoint on the western slopes reveals the unspoilt southwestern coastline of Mahé.

The island of Praslin, located 44 km northeast of Mahé, includes a hilly, central spine. The highest point is Mont Azore (367 m). Beaches on the eastern coast, such as Anse Lazio and Anse Chevalier, are scenic and contain outcrops of pink granite. Vallée de Mai National Park is part of a forested valley that has been compared with the biblical "Garden of Eden". The national park is a UNESCO world heritage site: the palm forests contain the iconic coco de mer *(Lodoicea maldivica*). The coco de mer is endemic to only two islands, Praslin and Curieuse, and yet was first observed and described by European travellers from the Maldives (where dead nuts had been carried by ocean currents).

Views from the granite hills: (a) beaches in the southeast of Mahé showing the fluted edge of a koppie; and (b) indented coastline, southwest Mahé.

Pink granitic boulders, Anse Chevalier, Praslin.

The source of the nuts was disputed for many years. The coco de mer has distinctively shaped (female) nuts that weigh 30–40 kg and 2 m-long (male) catkins. The nut does not float except when the husk has dropped off and is no longer fertile; thus the coco de mer has not been dispersed by ocean currents (as have other species of palms). In historical times the carved nuts were sold for large sums of money. The mythology behind the nuts has resulted in large numbers of visitors to the island of Praslin (including from cruise ships). The national park also contains endemic species of birds, e.g., Seychelles bulbul and Seychelles black parrot, as well as numerous endemic species of vanilla orchids. Several species of snails, e.g., the Giant Praslin snail (*Pachnodus paslinus*) are also endemic to the island of Praslin.[11]

(a) Vallée de Mai National Park, Praslin; (b) Seychelles Stilt Palm (verschaffeltia splendida) growing around granitic boulders in the NP; (c) coco de mer palm in the NP; (d) the distinctive nut of the coco de mer.

The island of La Digue is undeveloped, and the restriction on use of motor vehicles has created a relaxed lifestyle. Beaches such as Grand Anse and Petite Anse, which include clusters of pink granitic boulders, are equally as spectacular as

The granitic islet of St. Ave Maria is situated on the Seychelles Bank close to La Digue.

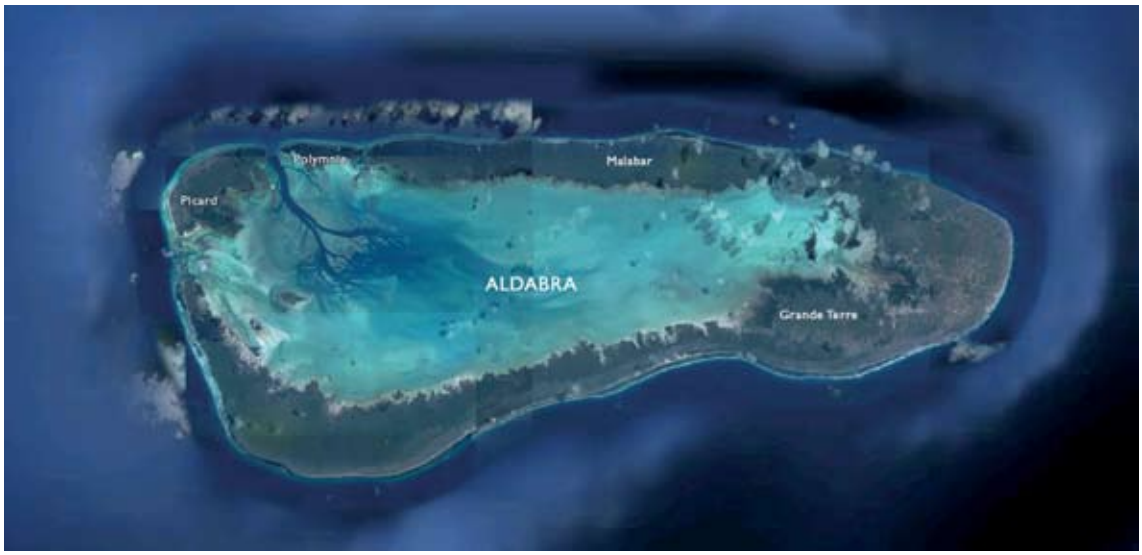
on Praslin. Surrounding islands (e.g., Felicite) and islets (e.g., St. Ave Maria) include fringing reefs that offer excellent snorkelling. La Digue is home to the critically endangered Paradise flycatcher (*Terpsiphone corvina*) and there are several endemic subspecies on the island.

Outer Islands

The two types of islands—coralline islands and coral atolls—found in each of the archipelagos of the Outer Islands are geologically discrete features.[12] Coralline islands are either raised coral reefs that occur in average sea depths of 25–70 m or are caps to submerged seamounts located in great depths. The maximum height of both the coralline islands and atolls is typically less than 5 m. Coral atolls are defined as ring-shaped coral reefs that encircle a central lagoon. Multiple islands are identified although the land area is small (as compared to the area of the lagoon). Atolls occur on the crests of seamounts or submerged volcanoes, an observation made by Charles Darwin as a geologist on board the "Beagle" (the second voyage of the British navy ship 1831–1836). As an extinct volcano subsides, due to volume loss and cooling of a subsurface magma chamber, coral growth, which can only occur in shallow water, results in the reef matching either the sinking of the volcano or sea level changes.[13] An alternative is the antecedent karst hypothesis in which atolls are envisaged to have formed in the Late Pleistocene due to low sea levels on the fringes of volcanic seamounts.

The Amirante archipelago is a group of eight single islands and three atolls (total land area of 11.5 km^2) that extends for over 155 km on a southward arm of the Seychelles Bank.[14] The three atolls are St Joseph, Poivre and Desroches. Located 70 km south of the Amirante are the Alphonse Islands, a group of coral atolls separated by a deep section of ocean. The two largest atolls are Alphonse and St Francis. The Farquhar Group (total land area is less than 13 km^2) are situated more than 500 km to the south and include two main atolls, Farquhar and Providence. The Aldabra archipelago comprises 46 coral islands and atolls and is closer to East Africa than to the Inner Islands. The archipelago includes both coralline caps to submerged volcanoes, and atolls.

Aldabra Island is the world's second largest atoll by land area (34 km by 13 km), although not by overall size. The central lagoon (area of 196 km^2) mostly dries at low tide. Aldabra Island is capped



Satellite image of Aldabra Island, the largest atoll in the Indian Ocean. The turquoise colour reflects the shallowness of the central lagoon. (Source: Google Maps)

by coral reefs that formed in the Late Pleistocene.[15] The reefs have an average width of 2 km. There are two raised beaches (6 m and 8 m above current sea level) that reflect discrete sea-level stands. The highest surface (age of approximately 125,000 BP) developed prior to the Main Ice Age. As with all coral atolls in the Indian Ocean, Aldabra Island has emerged and submerged multiple times. The island is part of a chain of extinct volcanoes (estimated age of 20 Ma) associated with a hot spot. The volcanic history is difficult to ascertain due to the sea depth; the seamounts are thought to have started to form in the Miocene.[16] The seabed in this region comprises old oceanic crust (estimated age of 150 Ma). The Comoros Islands (which lie 400 km southwest of Aldabra Island and contain several active volcanoes) equate to the current position of the hot spot. The Somalia Microplate is migrating northeast and the topographic expression of the seamounts decreases as they become older.

The Aldabra Islands contain numerous endemic species, as well as large numbers of seabirds and aquatic sea life. They are described by Sir David Attenborough as "one of the wonders of the world". Aldabra Atoll was designated a UNESCO world heritage site in 1982 and is a national park and RAMSAR site. The nearest airport is on the island of Assomption (50 km to the southeast), a single coral island (area of 11.6 km^2) with crystalline, white sandy beaches. There are specialised cruises to Assomption and Aldabra with an estimated 900 visitors annually to the latter.

The most well known of the endemic species on the island is the Aldabra giant tortoise (*Aldabrachelys gigantea*), which has an average weight of 250 kg. Over 100,000 individuals occur on the atoll (this is the largest population of giant tortoise in the world), and their herbivorous nature and grazing pressure has created a unique habitat. "Tortoise Turf" contains more than 20 species of dwarf grasses and herbs. A parallel may be drawn with the impact of African elephant in converting thorn bush into grassy savannahs. The fossil record shows that multiple species of giant tortoise formerly occurred on many of the Indian Ocean islands, including Madagascar. Extinction was in many cases driven by over-exploitation by the early explorers and sailors. The survival of the Aldabran species, the last remaining species, is therefore of great interest. Most of the giant tortoise located on Mahé, Praslin, and La Digue (which formerly contained endemic species) are mixtures of the Aldabra tortoise with various species of giant tortoises that went extinct in the 19th Century.

Sea-level Changes and Evolution

The sea-level changes of the Late Pleistocene and Holocene have a bearing on evolution of

Aldabra giant tortoise. (Source: alphonse-island.com)

endemic species. Most of the Seychelles Bank was exposed during the Main Ice Age. The location of the Seychelles on the fringes of the northern hemisphere icesheets assists with establishing sea-level variations during the glacial and interglacial periods.[17] The marine limestones in the granitic Inner Islands of the Seychelles formed during a range of sea levels. Radiometric dates indicate the main period of deposition occurred at 140,000–120,000 BP, i.e., during the last interglacial.[18] The study of interglacial corals shows the eustatic sea level peaked at 129,000–125,000 BP (7.6 ± 1.7 m higher than currently). This sea-level budget requires a major contribution from melting of the Antarctic icesheets. Since the Last Glacial Maximum (20,000 BP), sea level has risen by over 120 m.[19,20] The main rise occurred between 15,000–6,000 BP at an average rate of 10 mm/yr. Since 6,000 BP, average sea-level changes have been less than 0.5 m in total.

All photographs, unless otherwise referenced, are by the author.

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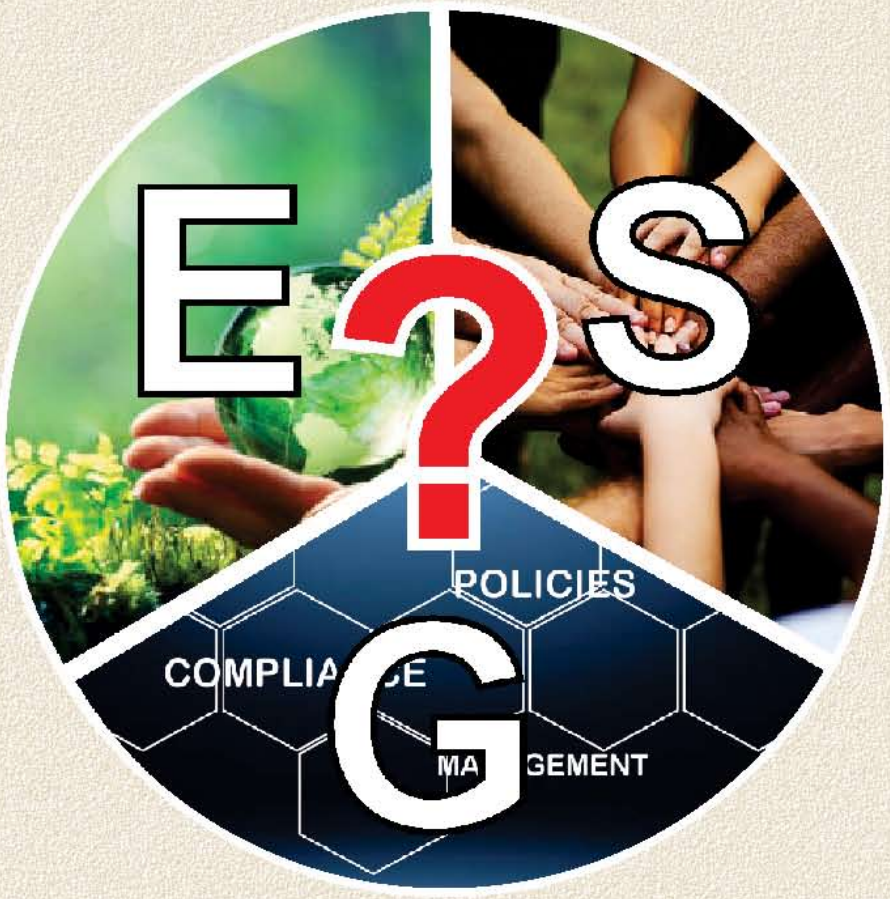
We are planning to hold talks and workshops helping members understand the shifts and changes in the ESG industry



Should you be interested in joining the ESG interest group, or would like to be included on the mailing list please email

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OxGVC 2022

Oxford Geoheritage Virtual Conference 2022

We would like to invite you to the Oxford Geoheritage Virtual Conference 2022. The conference is to attend and submit an abstract to—all you need is an internet connection and an interest in geoheritage! Please do feel free to share news of this year's meeting with anyone you feel will be interested.

OxGVC 2022 will take place from June 6—9, with keynotes, talks, and flash talks being presented each day between 2 pm and 5 pm UK time (BST = UTC+1). This timing is aimed at maximising international attendance. For the first time there will also be an opportunity for poster presentations. OxGVC is all about geoheritage workers being able to meet online—the presentations will therefore be supplemented by an online space for attendees to meet, discuss, debate, and socialise.

This conference is open to all who are interested in geoheritage, including scientists, students, professionals, policy-makers, and managers. We welcome contributions from all fields of geoheritage including geoconservation, management, classification, geodiversity, legislation, geoparks, geotourism, geoheritage and cultural heritage, and interpretation. Geoheritage is an inherently interdisciplinary field: we also encourage those from affiliated fields who have something to contribute to attend and submit an abstract. We particularly encourage early career workers to submit their abstracts for consideration.

You can find further information on our website: www.oxgvc.co.uk

Registration is now open, and will close at 23:59 BST May 30th

Abstract Submission is now open, and will close at 23:59 BST April 1st

OxGVC has a Facebook Group where you can stay up to date with news on the meeting.

Further information will follow regarding our online OxGVC meeting space, social events, and keynote speakers.

We very much look forward to seeing you online in June.

The OxGVC Organising Committee:
Jack J Matthews, Helena Tukiainen, Lubomir Strba, Taha Younes Arrad, Lucie Kubalikova, Catalina Gonzalez Tejada

2022 OxGVC
Oxford Geoheritage Virtual Conference

12 IKC POSTPONED TO 2022

The 12th International Kimberlite Conference is postponed to

15 - 19 August 2022

The postponement reflects the COVID-19 situation and resulting difficult times for the diamond industry together with the goal of maintaining the symbiotic mix of industry and academia that makes International Kimberlite Conferences unique. This change has the full support of the International Kimberlite Conference Advisory Committee

The intention is to host the 12IKC at the same venues in Yellowknife, with the same scientific programme, field trips, short courses and social events, but delayed by one year.

Further updates will be available on the 12 IKC Bulletin Board as well as via the 12 IKC mailing list.

We look forward to welcoming you to Yellowknife in 2022!

The Department of Earth Sciences at Stellenbosch University,
the Geological Society of South Africa,
the Igneous and Metamorphic Studies Group,
the Global State of Affairs, and the local state of the vaccine drive

regret to announce:

EVENT POSTPONED AGAIN

rates card 2022

excl VAT

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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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September issue:	15 August 2022
December issue:	15 November 2022

6. CANCELLATIONS

At least 4 weeks prior to deadline

7. 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.

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9. ADDITIONAL CONTACT INFORMATION

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