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The changing story of Groundwater Science
Mineral exploration at its peril
The Rwenzori Mountains and Semliki National Parks

news


GSSA
Geological Society of South Africa

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Front Cover:
"Climbing toward the twin peaks of Alexandra (left) and Margherita (Mount Stanley) on the Kilembe Trail, Rwenzori Mountains".

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guest editorial

Matthys Dippenaar

The Changing Story of Groundwater Science

We need nice stories about science, so we don't have to perpetually defend science in a world flooded by intentional misinformation and misrepresentation of skill. As geologists we face this constantly when we share the fascinating stories of the origin of the Universe, the history of the Earth, and the development of Life.

We sometimes face different, more real-life and close-to-home matters, where conflict is not necessarily due to differences in narrative, science education or belief. Here, science becomes a surrogate for issues pertaining to moral, ethical, societal and monetary injustice: energy, land use, mineral resources and groundwater—all fundamentally geological resources.

What makes water supply different to minerals and energy, however, is that water is a basic human right. This implies that water is supplied at extremely watered-down tariffs to make it accessible and affordable to all. While this is both commendable and absolutely necessary, it does result in reduced respect and appreciation for the resource. People tend to be more wasteful of something because it is free or cheap, making water management and governance a very difficult task indeed.

Most of us grew up with a friendly schematic version of the water cycle. A smiling water droplet accompanied you on a spectacular journey from a cloud to rain, and from a river to the ocean. With arms outstretched it yearned to be pulled up to the skies again to complete the circle of its existence.

Occasionally—rarely, but occasionally—we would see this droplet acknowledge the other 99% of the planet's fresh water. You would be so lucky to be accompanied to the ice caps and glaciers where water is in solid phase, or underground where water stays in openings in soil and rock as groundwater. Though two thirds of our freshwater occurs as ice and one third as groundwater, humanity is still biased towards that 1% occurring in rivers and dams. Almost all fresh terrestrial water is practically excluded from the narrative.

When we look at the story that is told, it is one of reservoirs to store surface water. When that runs out, we talk of augmentation by desalination of ocean water. Whatever happened to the water that we walk on, that shows some delayed response to climatic extremes, and that has some lower vulnerability to contamination and evaporation losses when compared to most surface water alternatives?

This is why no one blinks an eye when boreholes are drilled at random and at one's own prerogative. As long as the dam levels are monitored, the use of your groundwater is deemed your privilege—no, your right!—despite it being fundamentally wrong and in direct contradiction with our National Water Act (NWA; Act 36 of 1998).[1] The Act states very clearly that water is a natural resource that belongs to everyone and that—despite its uneven distribution—its use should be equal. This is echoed by our Constitution (Act 108 of 1996), which states implicitly that everyone has the right to sufficient water, and an environment protected from pollution and ecological degradation, and subject to sustainable development.

Abuse of cheap water affects the story of groundwater. When the sound siting and installation of water infrastructure outweigh the 'free water' you are looking for, then why in the world would you spend more on doing it legally, sustainably and ethically? Why would you opt for geophysics and models and testing when someone knows someone who has a gift and can do it for less? This makes it very hard for well-trained groundwater scientists to compete with fairy tales of

dowsing (or divining or witching; whatever hocus pocus term works). Science has been given a bad name.

It is a story so often told; one of the abilities of some individuals to site groundwater by some obscure means. But finding water is not the hard part. Practically all ground is wet at some depth. This is the premise of gravity, whereby water (or anything, for that matter) will go down as long as there are openings for it to go down into. No scientist has ever contested that. Finding water is not the skill.

Finding clean water, at acceptable yields, that will not adversely affect the environment or other users, both in space and time, and that will not falter in its yield—this is the skill. Doing this all subject to the SANS 0299 series (Code of Practice: Development, Maintenance and Management of Ground Water Resources), and subject to water use licensing requirements (NWA 36:1998)—this is the skill. This is where the science trumps the quackery, and where we need to be more forceful in protecting the water cycle from those without any respect of it (read, those who shamelessly mine or over abstract water, or those who knowingly pollute it).

This is where groundwater science comes in.

Hydrogeology or geohydrology (used synonymously for most purposes), the scientific study of groundwater, is a fairly well-established science with its roots very close to early-days civil engineering, geophysics, and of course, geology. It has developed to a science no longer concerned solely with water supply from boreholes (or wells), but to one understanding the complexity of the hydraulics of aquifers and its place within the greater water cycle.

No, we don't just pump boreholes. And no, groundwater doesn't come from underground rivers and lakes. It is more complex than that. I'd encourage everyone to start with the book by Nel,[2] and then to work through the amazing free online platform of groundwater science information at the Groundwater Project (https://gw-project.org).

We need to study the mechanics of the aquifer to understand the regional ramifications of lower water levels in boreholes. We need to understand the substantial significance of allowing water quality to deteriorate at one point in the water cycle.

Numerous cities and towns throughout South Africa are dependent either fully or partially on groundwater in the water supply mix.[3,4,5] Urban groundwater also brings with it so much more than just matters of supply, also requiring input into water-related disasters, flooding, flooding of underground infrastructure, sustainable drainage solutions, and so much more.[6,7]

Cities are very often founded on or near water to serve as transport corridors, or for nutritional (drinking) purposes. Cities are near coastlines or rivers. Yet Gauteng is on top of a significant water divide in South Africa, diverting surface water to the Indian Ocean by means of the Crocodile, Olifants and Limpopo rivers, as well as to the Atlantic Ocean by means of the Vaal and Orange rivers. The founding of Pretoria, which predates the discovery of gold and the founding of Johannesburg, is deeply rooted in the high yielding springs from the Malmani Subgroup in the present-day Fountains Valley Resort. As you enter the capital city from the Fountains Valley Interchange, you are greeted with fountains, reminding us of the two high-yielding springs around the corner. To this day, these two springs (Upper Fountain and Lower Fountain) supply in the order of a combined 30–40 million litres per day to Tshwane. The discharge from the springs has remained constant for the 160 years since its first use, and they now supply 5–10% of the City of Tshwane's water, together with some other springs and boreholes.

Unlike the karst springs in Pretoria, Cape Town itself has a number of springs associated with the Table Mountain Group that have contributed to the water supply of the city throughout its history. Even though the hydraulics of these springs is different from the karst springs in Pretoria, they also provide consistent discharges of remarkably good water quality.

One should never waste your word count with things everyone knows. Yet this needs to be said: South Africa is water scarce. South Africa's water is erratically distributed. South Africa is predominantly semi-arid to arid.

None of this matters. We have to make do with what the complex geological and geomorphological development of our country has left us, and how this is further compounded by the climate and the changing climate. We have to make do with the difficult job we have as hydrogeologists, and how this is further compounded by ignorance and miscommunication. We need scientists who can communicate science through stories that will captivate audiences and convert those who fall prey to dishonesty and misrepresentation.

Maybe the water cycle also deserves some herd immunity; an additional layer of care and resilience where it is possible, to attempt to mitigate possible adverse effects elsewhere where it is more vulnerable…

Hydrogeology is a fascinating science that South Africa is remarkably competent in internationally. Our hydrogeologists are well respected abroad, and we contribute to academic research, collaborative research, and the international professional bodies. As a country, we are hosting the 50th Congress of the International Association of Hydrogeologists in Cape Town as a joint partnership between its South African National Chapter and the Ground Water Division of the Geological Society of South Africa, in 2021. This is the third on the continent and the second in the country. What a wonderful opportunity to showcase our country's competence in the science of groundwater!

Hydrogeology is becoming increasingly important. The amount of work done by hydrogeologists in augmenting water supply during the recent droughts is astonishing. These teams spent months to years with geophysical investigations, field visits, modelling, hydraulic testing, and sampling to come up with water supply solutions that are sustainable in the long-term. As hydrogeologists, one needs to test and monitor to continuously verify and improve models. While these are very easily and very often neglected, the consequence of untested and unmonitored schemes is inevitably failure at the expense of the environment and the people. Water supply is as much a matter of drilling a borehole as driving is a matter of having a key, and doing it wrong is an enormous risk.

We no longer study and teach borehole drilling. The hydrogeologist of the twenty-first century has to manage the resource to ensure long-term sustainability and equitable access to the benefit of the people and the environment.

As scientists, we need a partnership with the public and a partnership with the environment. Our client is the Water Cycle, and it is becoming increasingly volatile in a time of climate change, brownfields developments, urbanisation and emerging contaminants. We should update the narrative; our stories should not only say that (groundwater-)science is fun, but that it is hard and that it requires skill and competence.

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executive manager's corner

Craig Smith

The first quarter of 2021 has been anything but normal, ranging from the shocking invasion of Congress in Washington DC on 6 January, to more local events such as a return to Level 3 lockdown status, and a less than scintillating SONA delivery more recently. At the same time, international equity markets are advancing nicely, and importantly for South Africa, a resource boom seems to be gathering pace. The medium- to long-term future for the platinum miners looks particularly bright.

In the last month, two issues for earth scientists have been given particular attention in the press and social media, and the GSSA plays a role in both of the issues. In the first instance, we are seeing very mixed messages on employment for geologists, and particularly for those in their early-career stages. Are South African universities producing too many geologists? Some consultancy groups are receiving numerous applications for employment, particularly from recent graduates or early-career professionals. At the same time, university departments indicate that the majority of their honours graduates are finding work or opting to pursue higher degrees. We are also seeing high numbers of SACNASP registration applications in Geological and Earth Science Fields of Practice, and excepting those who have just graduated and are applying for Candidate status, the majority is employed. (It is a legal requirement that professional earth scientists practising in South Africa be registered, irrespective of whether they work in industry, academia or government.) The GSSA member polls indicate that even during the pandemic, fewer than expected were retrenched or furloughed (on the order of 8%), though there was some loss of income for about 35% of those who responded. But the GSSA membership is not representative of the universe of geologists out there, judging from the fact that the majority of SACNASP registration applicants do not belong to a professional society of any sort. (Tip for younger job seekers—join a professional society to stay engaged with your professional peers!)

We are attempting to get a better understanding of the broader universe by running a survey through SACNASP, which will be reported on as soon as it is available. There has been very good participation, with just under a thousand respondents. The results are being analysed now. There is a perception that part of the employment conundrum is related to the second critical issue facing South African earth science. Is the relatively low investment in greenfields exploration in South Africa stifling employment of earth scientists? And what are the reasons for low investment in the sector? There is a (vocal!) school of thought that the regulatory environment is so pernicious that all but the most intrepid of investors move their money elsewhere. There is undoubtedly merit in this belief. The 2020 Fraser Institute Survey of Mining Companies has been released, and gives rankings in various aspects of 'attractiveness' to investment in the minerals industries of various countries. South Africa ranks poorly in the Policy Perception index, ranking 66 out 77 exploration destinations. For comparison, Namibia and Botswana rank 47 and 15, respectively—clearly streets ahead of South Africa in terms of the regulatory regime. (Zimbabwe and Venezuela are dead last in the ranking.)

In the overall Investment Attractiveness Index of the Fraser Survey, South Africa at position 60 has lost 20 places from 2019. Botswana, on the other hand, advanced from 45 to 11. There are clear successes in the sector in South Africa over the past few years, though most of these companies are involved in brownfields rather than greenfields efforts, by my definition at least. As a geological 'right address', South Africa is world class and would attract investment with appropriate—and sincere—regulatory fixes. As just one example, the mining sector of the Johannesburg Stock Exchange could be revitalised by

the introduction of a flow-through investment scheme. It need not mimic Canada, and might have benefits if applied to sectors other than mining and exploration, such as drug manufacturing.

It is unclear if the failure of the DMR cadastre management system has been factored into this poor ranking. For some years, the GSSA has been involved in commenting and lobbying the various acts, amendments and processes, and workshops have been run on the shortcomings of the SAMRAD system. Clearly, it is an impediment to foreign and local investment in the minerals sector and like many of the State Owned Enterprises, could only improve if privatised. After a decade of this performance, it is difficult not to conclude that this low bar was by intention, leaving the underlying premise that foreign investment is actually desired on shaky grounds.

Spare a thought for the policy makers and industry leaders setting long-term policy and strategy in a period of short- to medium-term change and political uncertainty. Over the next two decades, global efforts to minimise climate change will drive a great many long-term investment decisions. How will these decisions impact South Africa and the careers of earth scientists entering the workplace now? It is likely that we will leave fossil fuel resources stranded in the ground, for example, and this has major implications for the global cohort of specialist fossil fuel geologists. How do universities fulfil their mandates of supplying professional talent to industry while simultaneously producing the new generation of intellectuals the world will so desperately need? How does industry attract a young earth scientist into a field that might only have a decade of life left? (Hint—pay more money to young professionals!) And this has to be done in a 'post-truth' world where science-based practice is under assault, in particular in the world's most affluent country.

For an interesting opinion on the anti-science and alternative reality trends enabled and intensified by social media, read *Fantasy Land—How America Went Haywire—A 500 Year History* by Kurt Andersen (Ebury Press, 2018). It has nothing to do with science, technology or social media. It has everything to do with science, technology and social media.

Craig Smith

president's column

Sifiso Siwela

Fellow Members,

In my last *Geobulletin* column, I emphasised the resilience, grit and leadership displayed by the respective members of the Society. To further expand on the leadership theme, this column focuses on emotional intelligence and interpersonal skills, as well as their importance for effective leadership. Emotional intelligence (also known as emotional quotient or EQ) is the ability to understand, use, and manage your own emotions in positive ways to relieve stress, communicate effectively, empathise with others, overcome challenges and defuse conflict.

In this age of social media and instant communication, we have seen countless instances where a lack of emotional intelligence in leadership has caused

embarrassing newsworthy global events and the rise of populist movements. During adversity, such as the COVID-19 pandemic, as well as political movements and protests, leadership is critical for deriving well thought-out planning and execution, as opposed to decisions based on impulse. We have also seen even the most powerful of world leaders engage on petty issues and responding to trivial comments, rather than addressing more serious matters such as the pandemic and effects thereof. Childish rants and reactions to noise have become commonplace and have thus shifted focus from the important matters such as economic recovery. For example, significant job losses have affected the world over and even geoscientists locally have been affected, as was also presented in the results from our two membership surveys from 2020.

During Geoskills last year, I presented the five skills of the future, which highlighted emotional intelligence as a key skill in this world of artificial intelligence and this Future of Work we readily find ourselves in. Even though rapidly advancing technology is increasing demand for technical skills and digital fluency, the length of time a skill stays relevant in the workforce is, however, inverse and decreasing. This therefore means that humans should develop skills that can't yet be displaced by technology, and those that can generate value as the world changes exponentially. This means that soft skills will be also more critical in future.[1]

The digital transformation taking place today makes a new type of leadership possible and necessary. Leaders need to provide vision and purpose, empower people to think afresh, and collaborate across boundaries because a new inclusive culture of trust and respect is important.[2]

With the Future of Work's borderless ways of collaboration and diversity in today's multi-disciplinary workplace, effectively leading teams is more difficult than ever before. This diversity is displayed in terms of race, ethnicity, sexual orientation and identification (including LGBTQ+), as well as characteristics not yet known. Therefore inclusion, fairness, and social responsibility are some of the attributes that are expected of the current and new crop of leaders. Geoscientists are therefore encouraged to make a genuine effort to diversify their network, exhibit inclusive behaviours, and understand the realities of others. This attribute is referred to as cultural intelligence, a term that well-known geologist and mine developer, James Campbell, emphasised during the same Geoskills course. This distinguished geologist is also famous for leading by example by often changing roles, between the extremes of the field where he is actively exploring for diamonds in South Africa and Botswana, to roadshows and fundraising in London. The GSSA recognises that cultural intelligence is an important tool for a successful earth scientist and will continue to embed the concept in future events and workshops. The Society will also continue to expose members to a global community of practice, with emphasis on common societal concerns and topics such as environmental, social and governance (ESG) compliance and value beyond compliance, which are becoming more important factors and deal-breakers on mineral projects.

One of the skills I also discussed was challenging one's own thinking, assumptions and beliefs. The rise of social media and self-service consumption of volumes of information have caused people to indulge in bias that conforms to their own beliefs. The effects of this range from extremely polarised views, as has been observed recently in the USA, to unconscious bias. We as geoscientists should therefore be mindful of moments when our instincts seek out information that confirms own thinking. We need to challenge ourselves to seek out multiple perspectives and ideas that don't affirm our point of view or expectations. We should learn to suspend judgment and maintain open-mindedness and being truly informed through other reliable forms of information, over and above social media. This leads to building of courage, character and confidence for trying new ways to solve problems. Embracing failures should also be part of the process to achieving success. For example, exploration geologists in particular know how to capitalise on failure since the vast majority of prospects do not become mines. Grit and relentlessness

in the pursuit of discovery has in some cases yielded significant returns.

Exemplary leadership during predicaments was historically demonstrated by the Society's "founding father" Dr David Draper, who epitomised emotional intelligence and remained diplomatic in the conflict between Paul Kruger and John Cecil Rhodes. This quality enabled Draper to remain resilient and focus on humanitarian good, as well as geological missions, during this difficult time. This is the resilience and grit that I feel many geoscientists possess, due to being accustomed to extreme physical environments and pressures. Conflict management is a key aspect of emotional intelligence.

Emotional intelligence, which is demonstrated by appropriate reactions and decision-making, is also supplemented by sound scientific evidence where relevant. We have witnessed this locally during the pandemic, with how socio-political decisions were made assertively where scientific research was available. This is an important lesson to geoscientists, that science is very important for effective decisions, even in this age of reliance on information technology. Geoscientists need to constantly be aware that social media and open access has allowed any opinion or even theory to be shared across the world, whether proven to be factual or not. Geoscientists should use their sense of curiosity and knowledge to objectively filter through "fake science", which is being spread through a new wave of so-called "celebrity scientists".

Economic growth and recovery are being forecast for many countries in 2021 and therefore any significant decisions made based on impulse would be counter-productive to any progress or any national development plans. The current favourable commodity prices should be taken advantage of for the development of the mining industry and the economy at large. Geoscientists have recently mobilised a common voice for lobbying for the revitalisation of exploration and stimulation of investments in the mining industry in South Africa and hopefully this is supported by the respective government entities. We have observed unfortunate situations where an East African president made decisions on extreme forms of nationalisation that are detrimental and drove away those companies willing to invest in and develop the minerals industry.

Building resilience amid volatility is a trend for strategic leaders. In any uncertain environment, the key to success is agility and it is essential to be able to shift strategy accordingly, by monitoring the geopolitical and economic environment for early warning signs.[2]

The year 2021 has already proven to be another testing year and effective leadership will be more critical in overcoming the challenges. The uncertainty in many facets of our normal lives make it even tougher to plan and therefore lead effectively. Emotional intelligence is one of the attributes that will transcend the digital and other disruptions.

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letters

To the Editor,

Corrections for Geobulletin articles published in 2020

1. I wish to point out that in the obituary of Gerry Levine by Schie et al. in the June issue of 2020, it is erroneously stated that he passed away on 10 March 2020. In fact, Gerry passed away on 8 February 2020, according to his widow, Toni Levine. This clears up some confusion (in my mind), since on 10 March I was in the Himalayas, and I attended Gerry's funeral before I went to Nepal.
2. In my article on Nepal in the December 2020 issue, a couple of errors crept in:
   (a) On pp. 30–31, it is stated that the mountains Everest, Kangchenjunga, Lhotse, Makalu and Cho-Oyo are all found along the Nepal–Tibet border. As a matter of fact, Kangchenjunga, the third highest mountain in the world, is situated along the border between Nepal and Sikkim, which is a state in India. When I wrote the article, the height of Everest was 8848 m above sea level, according to all the best sources. In December 2020, however, a joint statement was issued by both the Nepalese and Chinese authorities, concerning a new measurement of the height of Everest, which is now officially 8848.86 m ASL (see BBC announcement of 8 December 2020: https://www.bbc.com/news/world-asia-55218443). The height of Everest increases by about half a metre every century, since it and the rest of the Himalaya are still rising.
   (b) In the caption of the photograph of Machhapuchhare on p. 32, it is stated that the view shows the east face of the mountain. In fact, the photograph shows the north-western face, as stated in the text of the article.

Sharad Master

mentoring

Mentoring and the Young Geologist

"Mentor, how will I stand before the king, how will I greet him? I am not good at sophisticated conversation: a young man like me might get nervous asking an older man questions."

Homer, Odyssey

"I Keep six honest serving-men:
(They taught me all I knew)
Their names are What and Why and When
And How and Where and Who..."

Kipling, The Elephant's Child

Introduction

The concept of mentoring dates to, at least in the western world, Homer's Odyssey, where the young hero,

Telemachus, commences his journey in search of his father, Odysseus, who has been absent for 20 years—one of the many suitors for Helen's hand. During his quest, Telemachus is advised by Athena, the ancient Greek goddess associated with wisdom, warfare and handcrafts (and of course the owl, a much more noble association than delivering mail to under-aged wizards). In her guise

as counsellor, Athena takes on the form of Mentor: an old family friend, advising, nurturing, and encouraging the young Telemachus. This widely accepted view of the origin of mentoring has been disputed, inter alia, by Roberts[1] and Colley[2]. Roberts is of the opinion that François de Salignac de La Mothe-Fénelon should be credited with the modern understanding of mentoring, with Colley analysing mentoring from a Marxist feminist perspective. She concludes, inter alia, that modern mentoring demonstrates *'a trend towards the weak mentoring the weak'*, rather than the *'powerful mentoring the powerful'*.

Understanding the context of mentoring and how its application has changed over time might not be of direct interest now, but is a worthwhile exercise to undertake, in order to understand the role that mentoring plays in your culture, society, or organisation.

However, what of Africa and mentoring? This aspect of mentoring will be explored more fully in my Geoskills presentation later this year, however it may be worthwhile reading Doreen Mueke's article *The Mentors Behind Great African Icons*,[3] where you will be introduced to such luminaries as Kwame Nkrumah, Patrice Lumumba, and Marcus Garvey. Sadly, Thomas Sankara, Frantz Fanon, Aimé Césaire, Wole Soyinka and Walter Rodney and many others do not make an appearance in the article.

The fact remains that the transferal of knowledge and wisdom (life skills) from an older more-experienced person (mentor) to a younger person (mentee), runs deep in the human condition. The relationship is well-developed both in fact,[4] as well as being demonstrated in popular culture, e.g., Buffy and Giles (Buffy the Vampire Slayer), Luke Skywalker and Obi Wan Kenobi (Star Wars), and Harry Potter and Dumbledore.

Closely related to the mentor–mentee relationship is that of the monomyth, or the Hero's Journey,[5] where the hero embarks on a journey of discovery, faces trials and tribulations, and returns empowered and emboldened with their new knowledge.

So how does all of this relate to the Young Geologist? I do not think it is stretching the analogy too far, if you consider that a move from university to the working world can be likened to that of a hero setting out on an adventure into the unknown, armed only with freshly acquired knowledge. In this new world, the rules are very different, often unspoken, and you will be faced with new foes that you must overcome or at least win over, including Snakes in Suits,[6] Corporate Hyenas[7] and Crocodiles ("*Come hither, Little One,' said the Crocodile, 'for I am the Crocodile,' and he wept crocodile-tears to show it was quite true*")[8].

In this brave new world, you will be required to 'Sell the Sizzle, Not the Steak',[9] Empower 'Brand You',[10] develop various forms of intelligence (depending on which of Daniel Goleman's books is flavour of the month), communicate clearly,[11] learn how to dance on burning decks,[12] swim in oceans blue,[13] survive melting icebergs,[14] be lean,[15] while thriving on chaos,[16] but also be able to swiftly, and successfully, follow the cheese,[17] wherever it may go.

This is not forgetting the need to become technically proficient (across a broad range of technical disciplines and sub-disciplines as well as varying software), be hardworking, on the bus, a team player, and professional regardless of the circumstances. Having a mentor is one of the ways that, especially first-generation, young professionals, can avoid Hamlet's dilemma:

"*'To be or not to be—that is the question. Whether tis nobler in the mind to suffer the slings and arrows of outrageous fortune, or to take arms against a sea of troubles, and by opposing end them*" (*Hamlet*, Act 3, Scene 1).

What is mentoring and how does it differ from coaching and teaching?

As has been mentioned, mentoring, in the classic western sense, is where a mutual and beneficial relationship is established between two individuals that facilitates the transfer of knowledge and life skills. This relationship might be formal or informal and might occur on an individual basis or in a group setting. The way mentoring is undertaken might also have cultural overtones and expectations—in the American context, mentorship is often framed as a mentor–protégé relationship, where a more powerful person (patron) actively influences the career of the junior. This practice may end up creating

a person who is totally invulnerable to censure or any form of criticism, no matter what they do, or do not do. Sometimes the person might be referred to as 'Royal Game', i.e., untouchable. In the United Kingdom and much of Europe, mentoring is, generally, seen in the context of developing a person; however, in all cases and cultures, patronage may (and does!) occur.

It is preferable that the mentor does not have line authority over the mentee. In my experience, it is further advisable that the mentor and mentee do not work in the same company. Opinions differ on this, however, and it is very much a personal choice. Not working together should allow for a freer and more widely ranging exchange of thoughts and ideas between mentor and mentee, creating space to challenge each other's perceptions and attitudes without a concern that the mentee's comments will be passed through the chain of command and entered (metaphorically) into his/ her copybook, as has been wont to happen in the past.

How the transfer of knowledge (epistemology) occurs in the mentor–mentee relationship is critical. Does the mentor consider the mentee a blank slate (tabula rasa) that must be filled with knowledge, or is the relationship based on mutual learning, respect, and exchange of ideas (innatism)?

In general terms, people refer to mentoring, coaching, and teaching interchangeably, depending on the context of the subject at hand. This sloppy use of jargon can be confusing and there are clear distinctions between the methodology used and the desired outcome of each.

Teaching (pedagogy) is probably the easiest to define and most familiar to us all. When we are taught, information is delivered in a formal and structured manner, with the understanding of the material being examined at critical stages of the process. A pass or fail regime is present, and the relationship between student (learner) and teacher is formal, hierarchical, and is normally a paid-for service. Blurring occurs if the teacher employs what is referred to as the Socratic method, wherein a debate/dialogue is entered, to engender critical thinking and to lay bare assumptions, logical fallacies, and bias.[18,19]

A coach, in contrast, provides training and instruction to achieve a specific goal or outcome. Typical examples are a sporting or athletic trainer. In most cases the coach is an older, seasoned veteran, no longer able to compete due to age, injury, or other reason (e.g., the late John Candy in *Cool Runnings*) but uses their acquired knowledge to allow the younger person (the protégé) to succeed.

And finally, mentoring—in this case the relationship is generally informal and relaxed; information sharing sessions and discussion (dialogue) should be free ranging. A mentor should also be able to give you sound counsel or censure if required and appropriate. Mentoring is normally undertaken freely without a cash component. From a personal point of view I am wary of people and organisations that charge a fee for mentoring. The relationship should grow naturally—as soon as money is involved the power equation changes; however opinions on this do vary and once again, this will be a personal choice.

A mentor will be able to provide guidance and explain the unwritten rules, the type of personalities (and individuals) to avoid and which to place your trust in, as well as the relevant skills to be acquired and demonstrated at specific points in your career.

They will also be able to provide career advice and present ideas, and sometimes, opportunities that you have not considered or were not aware of. A good mentor does not make you Royal Game!

A good summary and analysis of the difference between coaching and mentoring can be found on the Kent State University's web page.[20]

Choosing your Mentor

Deciding on a mentor can be quite tricky and most times, the 'best' person in their field might not be the best mentor for you. When you start looking for someone to be your mentor, consider these points as a minimum:

- What is their reputation (professional and social)?
- Would you be able to take criticism from them?
- Do they have the skills that you are looking to acquire?

- How do they communicate and how do they teach?
- What is your learning and communication style?
- Are they familiar with your industry/ organisation and can they provide valid advice and guidance?

Like most things, mentoring is a process and if you are serious about being mentored, take your time, do your homework, and choose the right mentor for the stage that you are at in your career—and there is nothing stopping you from having more than one mentor.

Types of mentoring

Mentoring can be undertaken in a variety of forms; the traditional one-on-one, face-to-face approach is by far the preferred way to develop a solid, long-term mentoring relationship. With the advent of modern communication technology, remote monitoring is also possible and feasible; however, being in the same or similar time zones is a distinct advantage.

A noticeable move is the phenomenon of reverse mentoring and this is where the mentee can assist the mentor. In the modern, diverse and inclusive work environment, attitudes toward work and society cover a wide range of mores ("*the customs and behaviour that are considered typical of a particular social group or community*" Oxford Learner's Dictionary) and expectations—this is where the mentee can provide guidance and advice to the mentor.

Other mentoring models can exist, such as peer-to-peer mentoring, group mentoring, and organisation-to-organisation mentoring and these will be discussed in the presentation.

The role of the Mentee

Until now, the focus has been on the mentor— this is the pattern that most mentoring books follow—however, what should the mentee be doing? What is your role in the process? During research for this article, I came across Lois Zachary's book *The Mentee's Guide: Making Mentoring Work for You*.[21] Zachary discusses mentoring from the mentee's point of view and provides practical advice to the mentee in terms of how to prepare for the mentoring relationship, how to deal with expectations and confrontation, how to determine boundaries and what attitude you (the mentee) should have when embarking on this journey.

Out of all the references cited, Zachary's is the one I would strongly recommend to those serious about being mentored. I would also urge you to read all the other non-fiction references, they will stand you in good stead for your future career.

The Geological Society of London[22] provides some good pointers for the mentee, as does the Association of Science and Technology Centers.[23] These have been adapted and summarised in the sections to follow.
As a mentee, you should be able to answer the following points to both your and your mentor's satisfaction:

- What do you want from the mentoring process? Have clear outcomes and objectives.
- Understand and accept that the mentor's role is not only to answer your questions and provide guidance and advice, but to challenge you as well.
- Prepare for your meetings; there is nothing more frustrating for a mentor than to have a mentee that is there for a free ride.
- Be prepared to listen, you might disagree, but be open to suggestions and different perspectives—get outside of your comfort zone.
- Do not become dependent on the mentor or make demands.
- Do not become romantically involved with your mentor.

Remember part of the role of a mentoring programme is for you to grow, both professionally, and as a person.

The role of the Mentor

And the mentor? (The following has been adapted from Johnson[23]).

A good mentor:

- Creates a foundation of support and mutual trust.
- Challenges the mentee to develop their own a plan for success and helps guide them.
- Gives actionable advice and feedback.
- Does not solve the mentee's problems or do their job for them.

- Provide critiques and feedback in an appropriate manner.
- Actively encourages feedback from the mentee, to ensure that the mentee is committed to the mentoring process.
- Knows when to terminate the relationship.
- Does not become romantically entangled with their mentee.

Things to consider

Some of these are repetitions of points raised previously, however they are critical to a successful mentor–mentee relationship:

- Avoid conflicts of interest. If you can, avoid being mentored by someone in the same company/direct line of reporting that you are in.
- Mentoring organisations may be an alternative option for mentees to consider and will be discussed in the presentation.
- Make certain that both parties understand their obligations as well as responsibilities—if needed, formalise this in writing.
- Establish (formally) the ground rules, such as how often and where you meet.
- What outcomes do you want to achieve? The mentor can assist, but unless you, as the mentee, take the time to think about what you want to achieve, you are at risk of both of you becoming frustrated.
- A sense of entitlement is a big 'no no'. Comments like "we demand that older people transfer their skills to new graduates", is not the way to attract a mentor.
- Make certain that you are both committed to keep your discussions professional and confidential (this includes social media).
- The potential mentor will research you as much as you have researched them.
- And finally, make certain that the goal, or goals, are discussed and agreed to, so you are both committed to achieving the desired objectives of the mentoring programme.

Concluding comments

I can think of no better way to conclude this brief article than by quoting Richard Bach, the author of Jonathan Livingston Seagull.

"*You are never given a dream without also being given the power to make it true. You may have to work for it, however.*" [24]

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Mark will be presenting more on mentorship at this year's Geoskills webinar in May/June 2021. Book your FREE seat now, to see how you can get the best out of a mentoring programme.

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all the news fit to print

WITS SCHOOL OF GEOSCIENCES

Two members of staff have been involved in new discoveries recently. Professor Grant Cawthorn, along with several others over a number of years, has been involved in the identification and characterisation of a new mineral: parahibbingite ($Fe^{2+}_2(OH)_3Cl$), a polymorph of hibbingite. The new mineral (Kodera., P. et al., IMA 2020-038a, *CNMNC Newsletter 59, Eur. J. Mineral.* 33.), was identified in samples from the Lonplats (now Sibanye Stillwater) mine, intergrown with talc, serpentine and tremolite that are replacing olivine in the Critical Zone of the Bushveld Complex.

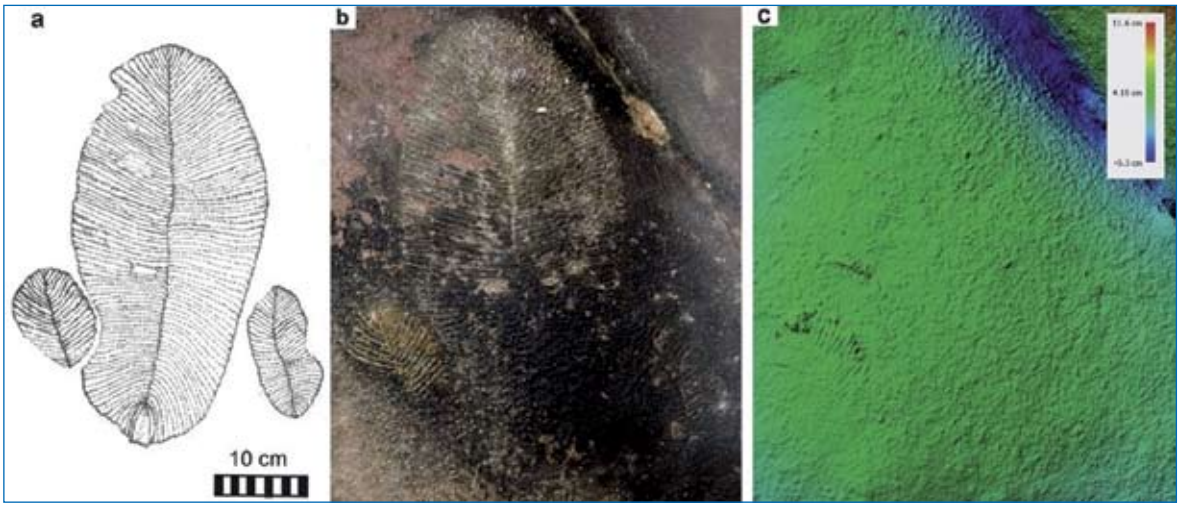
And in a rather serendipitous manner, Dr Sharad Master was one of the excursion participants visiting the cave at Bhimbetkar, in Madhya Pradesh (a UNESCO World Heritage Site containing the oldest palaeolithic rock paintings in India), where they discovered the first unequivocal Ediacaran (Late Neoproterozoic) fossil evidence found in India.

Details of the find have been published in Gondwana Research, as well as in an article that featured in the *New York Times*.

The Dickinsonia *discoverers standing 3 m under the fossils, located in the roof of a sandstone cave. It is a remarkable co-incidence that the accidental discovery of these Dickinsonia—where they were least expected to be found—was by an expert on them: Professor Greg Retallack (white shorts), who identified the fossils.*

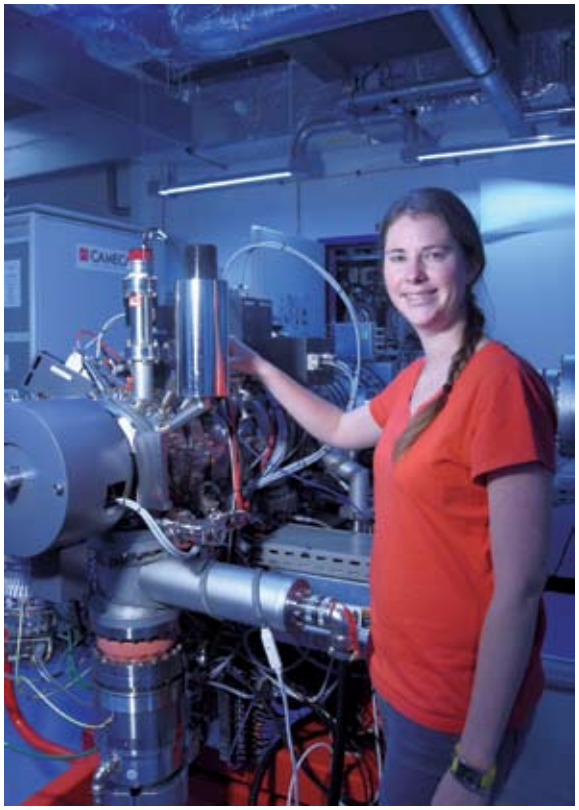
The fossil in question is Dickinsonia tenuis, a very distinctive and quite enigmatic fossil first found in c. 550 Ma rocks in South Australia, and subsequently in northern Russia. The cave in which the fossils were found is situated in the Maihar Sandstone of the uppermost beds of the Vindhyan Supergroup, which was thought, from detrital zircon dating, to be of Palaeo- and Mesoproterozoic age. However, the new fossil finding shows without a doubt that the youngest rocks in the Vindhyan range are around 550 million years old.

In other department news, Prof. Gill Drennan, Prof. Roger Gibson and Dr Stephanie Enslin developed a hands-on Vredefort Dome lesson, that was one of several picked to be turned into a virtual reality lesson by the company Edify. The Vredefort impact site has been well studied



The newly discovered specimens of Ediacaran fossil Dickinsonia tenuis.
a). Interpretative sketch by Greg Retallack.
b). Photograph by Sharad Master.
c). 3D microtopographic image, showing raised relief especially marked on the small fossil on the left, by Neffra Matthews.
From: Retallack, G.J., Matthews, N.A., Master, S., Khangar, R.G., Khan, M., 2021, Dickinsonia discovered in India and late Ediacaran biogeography. Gondwana Research, 90, 165–170.

Dr Glynn pictured alongside the 1280-HR Ion Probe in Potsdam, Germany.



owing in large part to its size, exposure and location in close proximity to the gold fields in Johannesburg. However, all of these data exist in 2D. By translating the existing data into 3D, the goal is to assist students with visualising the data (one of the biggest struggles for students in Geoscience), in order to better work with it.

Virtual reality headsets are limited, so the setup will be that the students experience the lesson through the headset that the lecturer uses. Development of the lesson will commence soon, and will for example allow students to:

- Strip back the layers of the impact site and manipulate them to better understand its 3D structures (the layers are based on interpreted seismic data and a 3D model generated from the data).
- Estimate the size, composition and speed of the incoming meteorite, and make an informed guess as to the extent of the damage.
- Discuss the longer-term impacts, such as water sources being vaporised and dust which when thrown into the atmosphere causes global temperate changes.

Lastly, Dr Sarah Glynn—who has been responsible for establishing the virtual SIMS (Secondary Ion Mass Spectrometry) Facility at Wits in partnership with the German Research Centre for Geosciences (GFZ)—officially joins the School as newly appointed staff.

Compiled by **Sarah Glynn** from various departmental contributors.

UNIVERSITY OF JOHANNESBURG

While several of our usual student fieldtrips had to be postponed, and the 3rd Years were guinea pigs to our first ever Virtual Field School in KZN, miraculously our Honours class was able to complete both their field excursions before the end of 2020, and to see (and describe, measure and map) some real rocks.

First up was the Advanced Field Mapping module, imaginatively named GLG8X07, but better known as 'the Northern Cape excursion'. After many emails between the department and university administrators, we finally got the green light to take five 4WDs and leave Gauteng and head west with our 10 Honours students for 11 days at the beginning of November. They certainly could not complain about staff-to-student ratios, as they had 4 academic staff and 4 post-grad students to help them understand the geology.

Under the leadership of Dr Herman van Niekerk, the trip went from our home on the Kaapvaal Craton to the Namaqua Metamorphic Province; as usual, it was the first time for some students to have left the craton. Although the trip had to be shortened and changed compared to previous years because of the pandemic, we still managed to get to one of our usual highlights: Tswalu Kalahari Reserve. Some of us will remember the area best for its marvellous outcrops of the rocks of the Keis Supergroup, but it's likely that the lions, snakes and thunderstorms may be the most vivid memory for most—the inclement weather certainly for those staff members who lost their tents!

Among other geological highlights were the pegmatites of the Areachap Domain near Upington, in which we even managed to find some beryl; the orbicular diorite

UJ Honours students mapping the spectacular transgressive sequence of carbonates to banded iron formation preserved at Kuruman Kop.

The first day at Tswalu Kalahari Reserve—pointed out on the map by Dr Herman van Niekerk.

near Concordia; and the 'steep structures' at Klondike. The breath-taking scenery at the latter location was certainly an added bonus.

After a week back in Joburg to submit final Honours Projects (and do laundry!), the class headed out once more, this time in the opposite direction, for their 'Basin Analysis' field school.

For 10 days the class meandered up and down the stratigraphy of the Natal Group, Karoo Supergroup, as well as Cretaceous to recent sedimentary units from Golden Gate National Park to a stretch along the KwaZulu-Natal coast. Students had the opportunity to explore a large selection of depositional environments, facies, fossils, and sedimentary processes under the guidance of Dr Clarisa Vorster, Prof. Bertus Smith, as well as Prof. Michiel de Kock. And also to spend some time on the beach, just before the festive season lockdown rendered this illegal!

Despite the pandemic, we all avoided the dreaded Covid-19, and injuries were restricted to one staff member flattening her toe by overly enthusiastic sampling of the Friersdale Charnockite. Although we all would have preferred to have seen more of the geology in these areas, as in previous years, we were overall quite glad to have managed our real field experiences in these times where virtuality appears to be replacing reality. There is simply no substitute for seeing real rocks in the field!

Contributed by **Marlina Elburg** and **Michiel de Kock**

Describing Holocene sedimentary rocks while standing on recent sediments at Richards Bay.

Mapping mineralised steep-structures at Klondike in the O'okiep Copper District, Namaqualand. How many students can you spot?

Maintaining social distancing rules in Golden Gate National Park.

STELLENBOSCH UNIVERSITY

With 2021 well under way, it is a great time reflect on the year that has just been. Or in 2020's case, perhaps better put as 'the year that has just not-been'! Lame dad jokes aside (see *Geobulletin* Dec 2020 SU news "More little geologists and palaeontologists enter the world"), by academic standards, 2020 was not a bad year for the Department of Earth Sciences at Stellenbosch University. Despite the setbacks thrown at us by that omnipresent virus, we were still able to complete our academic year timeously, graduate 33 post-graduate students (including 6 PhD and 7 MSc), and publish 51 scientific contributions to the earth sciences in international and national peer-reviewed journals. The current year follows this theme—times are still trying, yet we continue to do our utmost to provide good quality student training and high-calibre research outputs. Our teaching curriculum kicked off in January with the registration of 22 Honours students, all of whom are super excited to be back on campus for safely conducted face-to-face learning interactions. Our post-graduate enrolment figures also continue to rise, and part of this is made possible by generous post-graduate bursaries provided by Stellenbosch University, which help to fill the void left by diminishing NRF funding opportunities.

Our colleague leaves us for colder pastures

Prof Jodie Miller has recently immigrated to Vienna, Austria, where she takes up a position as the Section Head of the Isotope Hydrology Section at the International Atomic Energy Agency (IAEA). This is an exciting career opportunity for Jodie, who will almost certainly make a success of it given her strong research background in isotope geochemistry. Jodie made invaluable contributions to our Department over her 15-year tenure. These contributions included her excellent teaching and curriculum design initiatives, the countless students that she graduated, her involvement in the various societies, and her research outputs that spanned both isotope geochemistry and other fields of geology (e.g., metamorphic geology). Though we plan to stay in touch, Jodie will be sorely missed from our department and we take the opportunity to wish her all the best for her future career endeavours.

A successful Honours mines tour/field school was a great end to 2020

After a year of online learning and not having the pleasure of interpersonal interactions with their colleagues, the

Prof Jodie Miller has recently left SU to join the IAEA.

An eager cohort of 2021 Honours students listens avidly to the insights of Dr Susanne Fietz.

Honours class of 2020 were frothing to get together on a field school and to learn more about South Africa's geology and its mineral resources industry. The tour ran between 15 and 24 November and the shortened tour meant that as much as possible had to be crammed into the 3 400 km round journey, mostly focused on geology of the Western and Northern Cape. First stop was a lunchtime exploration of the olivine melilites associated with the Saltpetrekop carbonatite in Sutherland (a town also known for its minimum temperatures and a telescope). The stopover was a necessary break on the way up to Prieska, where we arrived as it was getting dark after experiencing two flat tyres.

Our first mine visit was to the Copperton project, a world-class polymetallic VMS deposit that hosts extensive exploration potential nearby. Here we were graciously hosted by Louw van Schalkwyk (a Matie alumnus), who provided us with an exceptional presentation of the regional geology and a great tour of the surface sites of interest (including the green malachite-stained discovery site). From here, we navigated some flash floods to arrive in Postmasburg for a night of anxious camping in the thunder, lightning and torrential rain of the area's first summer storm. The next day we took a round trip to the Pering mine, which is currently not operational, but which did provide good exposures of dolomitic stromatolites and an opportunity to see drill-core sections of the world's oldest Mississippi Valley-type Zn-Pb mineralisation. Thank you to Umbono for allowing us access to the site.

Between Wednesday 18 and Friday 20 November, we were treated to an extended field school organised, planned and run by Anglo American and Kumba Resources at their Fe operations in the Postmasburg area. This was an absolute highlight of the trip, in that students obtained high-level exposure to core-logging, drill-site safety and management, and to field exposures of high-grade iron ore on the Maremane Dome. We are greatly indebted to Lorena Tafur and Carel Burger for their efforts in putting this experience together, and also to Stuart MacGregor and his team of senior geoscientists who flew in specifically to provide our students and the students from UKZN with inspirational talks about a career in the South African minerals industry.

The next two days were spent with Shane Doggart, Hendrik Smith and Conrad Groenewald from the Council for Geoscience. Their first-hand knowledge of the Northern Cape area ensured that we had phenomenal field experiences of medium- and high-grade metamorphic rocks, Niobium-Yttrium-Fluorine-class pegmatites, amethyst veining, and the structures and deformation associated with the Pofadder Shear Zone. While in this area, the students also had an opportunity to experience the shear natural beauty of the Augrabies Falls. Our final formal stop was at Aggeneys, where Pieter Steinmann

Honours graduate Nathi Mthethwa enjoys experiencing the stromatolites at the Pering MVT deposit, host to significant Zn-Pb mineralisation.

The SU Honours class of 2020 pose at their year-end function (the theme was 'PPE').

and his team of geologists at Vedanta Resources introduced our students to the polymetallic Broken Hill-type Zn-Pb-Cu(-Ag) mineralisation hosted in their various ore bodies. Here the students split into three groups to maximise the diversity of the experiences. One third of the students donned their hard hats and respirators for their first underground experience, while the other two thirds were split between a visit to the core shed and a visit to the plant for interactions with the metallurgists. After a full day of these learning interactions, the students were treated to a formal year-end function at the Lemoenplaas campsite. This was the SU Department of Earth Sciences' way of saying goodbye and thank you to a great cohort of students, who had weathered the anomalous year with positive attitudes and a good degree of acceptance and understanding. The return trip between Aggeneys and Stellenbosch included two quick stops at geoheritage sites in the Springbok area, viz. the old copper-stained adit to the Van Der Stel Mine, and the interesting textures at Orbicule Koppie.

A final note of thanks is extended again to all the mining companies and to the Council who went out of their way to make the 2020 field school possible. Because of the pandemic, it was incredibly difficult to organise such a tour, and its successful completion is directly attributable to the generosity of all those who offered their time, insights and access to field sites. A special vote of thanks goes to Kumba/Anglo for their extended three-day field school offering, from which students of SU, UKZN and UCT all benefitted. This certainly is a model for how dedicated industry outreach can maximise the experiential learning value for university students.

Maties alumnus gives Malawian economic geology a jump-start

Upon returning to his home institution as a lecturer in Economic Geology at the University of Malawi, Polytechnic, Dr Joshua Chisambi has been quick to get involved in setting up a brand new Economic Geology laboratory. Their new equipment includes drones, thin-section machines, petrographic microscopes equipped with high-calibre cameras, new computer labs, rock crushing and sawing equipment, among other items. Joshua graduated with a PhD from SU in December 2020 with a thesis entitled "*Gold mineralisation in the Kirkrange area, southern Malawi*". He is actively employing the skills that he developed at SU, both in his capacity as a lecturer and as a researcher. We wish him the best of luck as he sets out in his career, and hope that the ties between SU and University of Malawi will go from strength to strength.

Bjorn von der Heyden

Dr Joshua Chisambi inspecting the equipment set up as part of a new economic geology research hub at the University of Malawi.

mineral exploration

South Africa neglects mineral exploration at its peril

Introduction

South Africa is currently attracting just 1% of global exploration spend, which in total amounts to about US$10 billion annually, as compared to 14% for Canada, 14% for Australia and 13% for the rest of Africa.[1,2]

The country's mining sector has many legacies that have contributed to distrust and a perception for a significant part of its population that the industry has done little more than create holes in the ground, lasting environmental damage, a disproportionately high injury and loss of life.

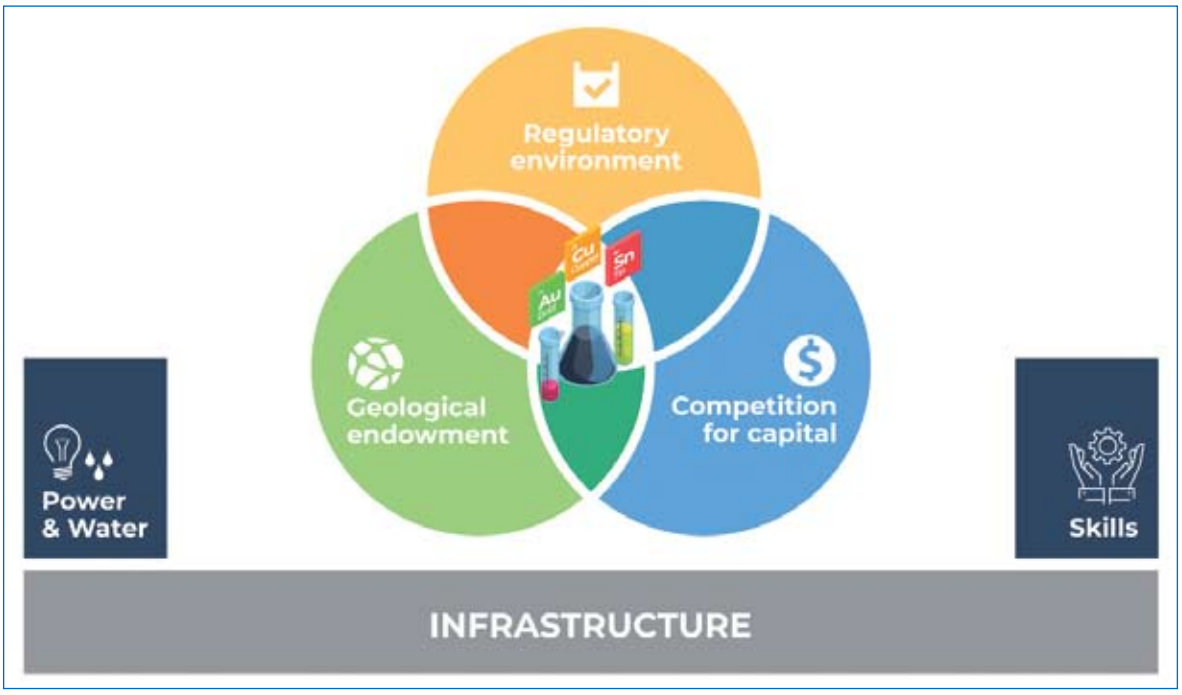
Emphasis on improved mine health and safety is to be commended, as is other change such as the new Mineral and Petroleum Resources Development (MPRD) Act 28 of 2002. It initially opened the playing field to all players and led to a short-term increase in new project development.

In the previous decades, only a few major mining companies controlled the South African mining industry and there was little opportunity for smaller mining companies and explorers. Exploitation of smaller deposits, relative to mega-deposits such as those of the Bushveld Complex and Wits Gold Basin, largely ceased after the Second World War, and exploration was forgotten.

The country missed the prior mineral boom of 2003–2012 due to ineffective policy and the absence of publicly available geological and geophysical information, and prior exploration data to facilitate high-risk exploration activity.

South Africa still has a rich endowment of unrealised mineral potential (see the table of prospective areas below) but is lacking in every other respect, particularly with regard to enabling mineral policy and access to capital. It is also grossly under explored in respect of modern exploration models and technology.

Enabling policy interventions and a revival of exploration should be at the forefront of creating a modern, transformed, and technologically advanced minerals and mining industry, and thereby to unlock untapped



Venn diagram highlighting the structures and parameters that drive mineral exploration (source Paul Miller)

mineral deposits, attract investment and create employment, which should be measured against the highest environmental, sustainability and governance standards.

Key Exploration and Development Interventions

Reviving exploration should be a priority for the country and to do so requires the following interventions:[3,4]

1. ***Implement a globally competitive and transparent digital cadastre:*** The SAMRAD system requires replacement with a functional, online cadastre to manage applications for mineral rights and ongoing licensing obligations, including the submission of all exploration data annually. This information must then form part of the public cadastre once licences are relinquished.

2. ***Effective administration by the Department of Mineral Resources and Energy:*** Years of maladministration and litigation have destroyed trust. A well-trained functional DMRE, with quick processing of licence applications, vigorous enforcement of the *use-it-or-lose-it* principle, fair and objective administration of the regulations with limited discretion, and fixed administrative time limits, is required.

3. ***Access to exploration information at no cost:*** Geological, geochemical, geophysical and historical borehole information and maps must be offered to all exploration companies by the Council for Geoscience (CGS) at no cost. The state needs to continuously invest in geophysical data acquisition and related data compilations, and provide such information on open file to ensure competitiveness and attractiveness of the country as an exploration locality.

4. ***Reform of current mineral policy, legislation and regulations:*** The MPRD Act and extra-legal Mining Charter process are no longer fit-for-purpose, are fundamentally backward looking and aimed at transforming historical assets that will soon be mined out. Policy uncertainty is now entrenched, with Mining Charters I to III and Implementation Guidelines plotting a progressive trajectory of ever more onerous demands and uncertainty. Unharmonised environmental legislation in the form of the National Environmental Management Act has resulted in substantial time and cost increases, which are unaffordable to small and junior companies.

5. ***Graduated mineral regulation for different scale enterprises:*** There must be recognition that small, junior and large mining companies require appropriate levels of regulation; the 'one size fits all' approach is counterproductive. The 'junior explorer' model has proved to be successful internationally; discovery of small deposits often leads to discovery of extensions and larger deposits, especially in 'elephant country' such as South Africa. Junior explorers need a conducive mineral and financial regulatory environment to attract funding and operate successfully.

6. ***Balance South Africa's administered cost burden relative to its mining peers:*** All countries impose non-production-related costs on mining companies. These costs must be stable, predictable, and competitive relative to other jurisdictions. South Africa imposes high corporate taxes, mineral royalties, formal social obligation costs, complex local procurement rules, and obligatory national ownership of at least 30% rising to 51% in some commodities (BEE, employee and community ownership), with part of this a free carry at the investors' expense. This is a key reason why South Africa cannot attract new investments, and requires decisive action by government to break the trajectory of ever-increasing non-production costs by actively working to reduce these costs across the full exploration-to-mine value chain.

7. ***Access to finance and capital flows*:** Successful junior mining countries all use tax incentives to both direct investment into mineral exploration and to develop and increase participation in public investment markets. South Africa needs to urgently implement a flow-through share or similar scheme that achieves both these objectives.

Related Investment Challenges

The above list focuses on creating a new and sustainable

exploration environment for the country. Other challenges listed below are also discouraging new investors and explorers, and require solutions:

- ***Crime and corruption*** is endemic to private businesses, public institutions and enterprises throughout the country. Large mining companies face regular precious-metal theft from refineries, while small operators experience threats to product security, property and life. Poor service delivery due to the dysfunctional state, provincial and local government has also led to communities pressurising mining companies to increasingly support community needs.

- ***Illegal mining*** is prevalent countrywide, causing loss of life, environmental damage and financial loss to RSA estimated at R21 billion in 2019,[5] with proceeds also financing other destabilising activities. Organised criminal networks underpin this situation and it will require well-coordinated initiatives from law enforcement agencies and the courts to address this risk. Appropriate policies and governance structures are required to formalise illegal and artisanal mining, and ensure the sale of products through transparent marketing structures.

- ***Unreliable Eskom electricity supply*** and the increasing costs of electricity, blackouts and delays in privatising and opening the sector to renewable energy are a serious impediment to new investment. Given the age of most of Eskom's existing generation fleet, crippling debt, and the unreliable generation capacity of Kusile and Medupi, the energy sector should be unshackled and free-market rules applied.

- ***Logistical bottlenecks*** have increased over the past decade due to a paucity of new capacity coming on stream, with marginal improvements apparent in coal and iron-ore capacity, and some growth in chrome and manganese exports. Repairs, recommissioning and modernisation of railroads to ensure greater efficiency and lower cost structures significantly outweigh the cost of maintaining and rebuilding public roads due to the impact of increasing road transport and haulage from neighbours.

- ***Declining competitiveness*** is increasingly apparent across all industries owing to a lack of reinvestment and modernisation such that far too many of South Africa's large companies, including mining entities, are sitting at the top of the cost curve. Enabling policies and strategies that will unlock the potential of SMMEs and entrepreneurs are overdue in all the business sectors.

Dedicated Exploration Support Structure

The need for a new representative and professional, *future-focused*, mineral-exploration and development support structure, capable of lobbying, educating, promoting and facilitating the creation of a robust exploration sector, was highlighted by participants in a series of Zoom presentations made by highly experienced and successful exploration geologists in late 2020 as part of a 'Reviving Exploration in RSA' programme organised by the Overberg Geoscientist Group.

Given RSA's embedded mining history, existing institutions are *backward focused*, do not fully appreciate the entrepreneurial and high-risk nature of mineral exploration, and are incapable of the paradigm shift required to cultivate a proactive exploration culture. It is crucial that the role of entrepreneurs, and genuine small and junior explorers and miners, is recognised and acknowledged, and that they are provided with a platform to highlight their challenges, skills, capabilities and ability to unlock value.

Genuine explorers are by nature entrepreneurs and risk takers. They require support, enabling policy and creative funding, including access to foreign exploration funding that has an appetite for high-risk projects, otherwise exploration will be a dead duck and the mining industry will continue its downward trajectory. A structure that has leadership and management experience in exploration should be a prerequisite. Existing local mining structures lack exploration memory and experience, and have in the past defended the absence of exploration in RSA with statements that "*we have found all that there is to be discovered*".

Examples of successful enabling exploration structures found in other international mineral-rich jurisdictions include:

- The Nevada mineral coalition
- The Association of Mining and Exploration companies
- The Prospectors and Developers Association of Canada
- Kazakh Invest

Geological Information

Access to historic and recent geological and geophysical information is key to discovering new mining districts and deposits. South Africa has an immense amount of older information, including geochemistry, geophysics, bore-hole logs and drill-core data, collected by mining companies in the past at a cost of billions of dollars, which is in danger of being lost (if not already lost).

Mining company Sibanye-Stillwater, for example, has a large data/drill-core depository, which probably contains the historic Wits exploration work undertaken by Gold Fields, Gencor, JCI and their subsidiaries and predecessors. There is additional information with Harmony Gold, including some information originally from Anglo American, Anglo American Prospecting Services, Anglovaal and their subsidiaries and predecessors. These data are not confined to Wits gold, but also include off-shore gold project work. Anglo American Gold, which recently exited RSA, presently retains a large collection of drill core and exploration data that are available on sale.

Importantly, the Wits exploration drill core includes out-of-Central Rand Basin drilling and contains unique deep drilling (+3 000 m) of core from the western, southern and eastern Kaapvaal Craton, probably never to be repeated. These data correct and enhance the extensive Kaapvaal Craton vibroseis data. Apart from other conventional mineral exploration aspects, the drill core also has critical relevance to the structural history of the Kaapvaal Craton, which has mostly been focused on the Witwatersrand succession, while the structural aspects of the overlying successions through which the boreholes were drilled have largely been ignored. The drill core and data have critical significance to nickel, gas and helium exploration.

Historical geoscientific data are of immense material and national significance, and where necessary retrospective mining regulations should be implemented to ensure that expired licence tenures (i.e., no longer held) revert to the state archives and can be used by explorers to ensure sustainability of South Africa's mining industry to 2050. Proactive submission of such data to a national archive and repository submission of data should equally be acknowledged and respected.

A collaborative programme involving industry, the CGS, and the GSSA to secure funds to ensure that professional staff are employed to capture and collate this invaluable company information, is overdue. These historical data and hundreds of kilometres of core represent a national treasure that should be preserved, collated, digitised and made available for explorers and students to utilise, or retained in a 'research institute' outside of political interference.

Maps, data, reports and geophysical information collected and produced by the CGS (and its Geological Survey predecessor), including core and records in the Donkerhoek core facility, should also be catalogued and made available on a no-cost basis for use by explorers. Over the past decade and longer, the CGS has undertaken geophysical surveys in Namaqualand, the central parts of the Northern Cape and the southern Free State, which should be available on the same no-cost basis. State institutions like the CGS are funded by taxpayers and have an obligation to provide services to citizens and investors to unlock mineral assets to ensure future employment, taxes and revenues for citizens.

South Africa requires new investment and Foreign Direct Investment (FDI). Exploration, discovery and development of new mines, and the jobs, revenue, royalties and taxes that follow, grossly exceed the revenue generated by sales of old data and information that taxpayers have already funded.

RSA Prospectivity

South Africa has been a mining country without a history of genuine greenfields exploration. With few exceptions, practically all the known large mineral deposits were located or discovered by ancient people smelting for implements and weapons, early settlers, prospectors and farmers. There are few, if any, other places in the world where mega-deposits such as the Wits Basin, Bushveld Complex and West Coast diamond placer (and its Namibian extension) have supported mine development over 100s of kilometres of continuous strike for some 150 years.

To drive exploration, the country requires re-mapping, modern geophysical surveys and access to historical data collected by the mining companies. Ensuring transparency and availability of information to support data gathered by new exploration initiatives is essential. Modern IT tools, including cloud-based computing, big-data visualisation, artificial intelligence, GIS, satellite imagery and 3D software, are all routinely available to exploration geologists to locate anomalies and make discoveries. Collating and providing digital information at no cost to new explorers should be a priority for the State, in particular through the CGS.

Summary of prospective areas in respect of typical commodity assemblages and new-age minerals (e.g., for electric vehicles, modern storage batteries and other smart technologies)

	Commodities	Area(s)	Comments
1.	Cu, Zn, Pb, Au, Ag	N Cape (Gordonia, Bushmanland, Namaqualand)	Numerous deposits, prospects, occurrences
2.	Ni, Cu, Co, PGM, Au	N Cape (Gordonia, Bushmanland, Namaqualand)	Several magmatic occurrences
3.	W, Sn, REE	N Cape (Gordonia, Bushmanland, Namaqualand)	Numerous deposits, prospects, occurrences
4.	Ni, Cu	Free State, North-West, Mpumalanga	Numerous mafic intrusions with mineralisation, larger systems?
5.	Zn, Pb	Eastern N Cape, North-West Province	Numerous dolomite-hosted MVT deposits
6.	Fe, Mn, REE	N Cape iron & manganese fields	Extensions of iron and manganese deposits
7.	Diamonds	Free State, Mpumalanga, Limpopo, North-West, N Cape	Large areas with no or few known kimberlites; pre-Karoo kimberlites
8.	Au	Wits gold	Western margin of the basin, including Bothaville Gap; Weltevreden decline (shallow potential opportunities)
10.	PGM	Bushveld Igneous Complex (BIC)	Some areas with underexplored potential; incorrect mapping & geological interpretations necessitate revisiting areas
11.	Ni		
12.	Au	BIC satellites and sills, eastern escarpment, areas in Mpumalanga	Potential for further 'Uitkomst-type' deposits with new exploration methods
		Greenstone belts	Smaller-scale deposits, largely ignored by the majors
13.	Au	BIC aureole	Mined pre-1960s, largely overlooked by majors; smaller-scale opportunities; industrial minerals
14.	He, shale-gas	Free State, N Cape, E Cape	Large areas of geology with potential for helium traps, e.g., Star diamond mine yielded abundant He; Karoo shale gas deposits yet to be adequately prospected/evaluated

Education and the Anti-Mining Lobby

Mining has been embedded in the public consciousness as a dirty, non-innovative, outdated and environmentally harmful industry. In South Africa there are significant legacies, including migrant labour and its impact on family structures, single-sex hostels, mine fatalities and silicosis, which have compounded the situation. Resistance to mining[6] and exploration, and mining companies, has increased locally and internationally over the last 20 years. The expanding anti-mining lobby is well resourced and strident about the legacies and history of the industry, much of the criticism justified.

Education and exposure to the benefits of exploration and mining is a necessity in South Africa. Every activity and minute of our daily lives is shaped by minerals and mining, be it through smart phones, computers, IT systems, work and living structures, power, water, or our diverse infrastructure and transport options that provide services, goods and food supplies.

There is an urgent need for school and educational programmes that involve the youth in exploring earth sciences, mining and mineral-exploration industries through innovative learning activities. Teachers should be equipped with curriculum-linked classroom resources and offered professional development training to teach curricula related to mineral resources that will inform youth about the importance of minerals, and career opportunities in mining and exploration.

Practical programmes are required to educate rural communities and schools about ways of better utilising local resources for building, crop growing, water management and combatting soil erosion. Some of this outreach and education is underway in programmes being driven by geoscientist Dr Wendy Taylor in Cape Town, and the P5 Project in the Transkei is working with traditional amaPondo leaders, communities and school children to build trust and shared knowledge systems. Much more of this is needed.

The *Mining Matters* of Canada organisation is a useful example for review. This charitable organisation is dedicated to increasing young people's knowledge and awareness of earth sciences and the minerals industry, and their roles in society. The organisation provides practical geoscience information and advice about opportunities in the minerals industry. It also offers educational resources that meet provincial school curriculum expectations that are created by educators and earth science experts.

Investors and shareholders are also increasingly insisting that mining companies place greater emphasis on the environment, communities, governance and accountability (ECG), than just the bottom line. There is a need for transparency, stronger and more inclusive leadership, and a compact whereby all stakeholders are better informed, educated, and able to formulate a shared vision of inclusive growth and prosperity and a licence-to-operate that addresses and avoids past legacies and mistrust. Jurisdictions that ensure transparency and responsible stewardship of mineral resources will become increasingly attractive to exploration and mining companies, whereas those lacking these criteria will be short-changed.

Lost Opportunity

Those who profess to have an interest in ensuring that there is a reboot of greenfields exploration in RSA, and the revival of the mining industry, should revisit a 1968 publication[7] authored by Des Pretorius, a doyen of South African geology. This short treatise highlights his and other experts' views on the challenges facing the industry back then, and the need for mineral exploration:

- "*If it was not so in the past, then exploration must, in the next twenty years, become the most fundamental operation in mining. Only it can keep the industry alive.*"
- "*More geologists will have to be attracted to exploration in order to satisfactorily execute the expanded programs that the future will bring.*"
- "*At least one university in Southern Africa will have to found an outstanding school of mineral exploration….*"
- The article further notes the need for a project pipeline "*to find and acquire a maximum number of new economic mineral deposits*" and the risks are high given that "*the losers outnumber the winners by at least one hundred to one.*"

Unfortunately, the experienced and informed counsel of Pretorius was never actively pursued. Nor has it been

considered seriously at any time in the past 53 years by the local large mining industry, or by the ANC government that came to power in 1994.

Conclusions

South Africa is in a dire state, with runaway debt, corruption, poor service delivery, rampant unemployment and a mining industry in decline[8] due to ineffective policy interventions, a dysfunctional DMRE, scarcity of new capital investment, and the exit of companies and investors. An exploration-driven paradigm-shift is required to revive the minerals industry, reboot the economy, reverse job losses, and address the plight of young graduates increasingly unable to find employment.

Since taking office in 2018, President Ramaphosa has targeted an investment drive to raise R1.2 trillion over five years, and hosted three investment conferences that have delivered pledges of about R770 billion. In November 2020, he unveiled infrastructure projects worth R340 billion out of a total of R2.7 trillion identified by the government and private sector. In February (*Business Day, 1 February, 2021*) Minerals Council South Africa (MC) President Mxolisi Mgojo stated that President Ramaphosa's interventions are unlikely to deliver the short-term benefits urgently required by the economy, further noting that government has neither the capacity nor the money to implement an investment programme of this size, and proposing stronger reliance on the private sector.

Why have the private sector, local geology and mining professional bodies, and the MC that previously played a prominent leadership role in South Africa's economic development, only recently highlighted their concerns about the inability of government to deliver? There have been court cases regarding BEE requirements, endless engagement regarding Mining Charters I to III, and broad proposals for more exploration from business organisations, government and the MC. Regrettably, a transparent, coherent and robust process of engagement and planning, which also draws on the immense experience, track record and successes of numerous local exploration geologists regarding mineral policy interventions and the need for exploration, has been notably absent.

The lack of robust leadership, engagement, and cohesive approach by the MC, GSSA, SAIMM and other industry structures is stark in this respect and reinforces the need for a focused and independent structure to revive exploration in RSA, drawing on the immense entrepreneurial and exploration experience and skills that already exist.

South Africa is likely to forsake considerable benefits from its mineral endowment if the current situation persists. Regrettably, the clause in the 1955 Freedom Charter, drafted largely by Joe Slovo, which stated that "*the mineral wealth of the country shall belong to the people*", will not be realised unless a comprehensive exploration strategy is implemented as a priority.

John Bristow, **Gerhard Meintjes** and **Graham Gavine**

Contributions from the numerous experienced exploration geologists who participated in the Overberg Geoscientist Group Zoom minerals exploration series in November/December 2020, in particular Regina Molloy, Paul Miller, Bill McKechnie, Thibedi Ramontja, Adrian Reynolds, Allan Saad and John Blaine, are acknowledged.

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geology and terroir

Geology and Terroir in the Stellenbosch Region of South Africa

The Stellenbosch Region is the most important fine-wine-producing area of South Africa's nine regions, where the Mediterranean climate, combined with favourable soils and excellent wine-making skills, contributed R36 billion in 2019 to South Africa's Gross Domestic Product. In that year South Africa, with a production of 1.2 million tonnes of grapes, producing 973 million litres of wine (of which 44% is exported), was ranked 15th in the world in terms of area planted.[1]

Wine-making is similar to mining, in that it is a capital-intensive, long-lead-time business, often at the mercy of the elements. New vineyard establishment is costly, depending on the soil preparation, and on the selection of trellising, irrigation and rootstock. First yields are often only after a number of years, depending on the cultivar, and capital returns are measured over decades before replanting is necessary. Proper viticulture is costly, and poor vineyard maintenance can negatively impact capital returns over time.

The ground, the vine and the wine

The taste of a wine is a complex interaction between climate (rainfall, sunlight and wind), topography (altitude, slope intensity and orientation), water sources, soil/geology (bedrock geology, overlying soils and soil formation), irrigation and fertilisation, allied to the influence and expertise of the viticulturalist and winemaker.[2,3] This complex combination of inputs, collectively known as terroir, produces a wide diversity in wine taste and quality, which are enthusiastically and often extravagantly described by wine experts and pundits the world over.

In the past decade, in particular, wine tastes and flavours have often been ascribed to geological factors, and geological terminology has become common on wine labels and in wine descriptions.[4] Metaphorical appellations abound, such as in "flinty" taste, or "granitic" flavour.

According to Shange,[5] the vine–soil relationship is the least understood in viticulture research. A few inconclusive studies have been done in South Africa,[6] but no direct relationships have been found between soil parent material and grapevine growth, wine quality and/or wine character.

However, it is accepted that the depth of weathering, the nature of the weathered profile, and deep soil preparation are critical elements in ensuring healthy vine root growth.[7] They estimated that 80% of the vine root system is developed within the first metre of the soil profile, with deeper root systems searching for additional moisture and nutrients.

The potential nutrient content, particularly of potassium and nitrogen, of the original geological materials differs and in cases where there are no deficiencies of other essential elements in the soil, potassium is among the elements that may have a material effect on wine quality.[5]

Addition of available nutrients by cover crops and fertilisers makes the quantification of the contribution of soil nutrients to that of the plant more difficult. Furthermore, once nutrients are taken up from the soil, genetic properties of rootstocks and scion material, environment and judicious viticultural practices can change the distribution of elements within the vine.

Nevertheless, the geological substrate and associated soils are critical first determinants in assessing the suitability of different areas for vine cultivation.

This note looks at the overall geological characteristics of one of the Cape's premier producers, and takes a holistic view of the favourable influence of the geology on vineyard distribution, from a substrate, soil formation

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and topographical point of view. A direct comparison between the geology and the wine quality has not been attempted, but hopefully this note will inspire further informed debate on this subject among the readers.

An Example from Rustenberg Wine Estate

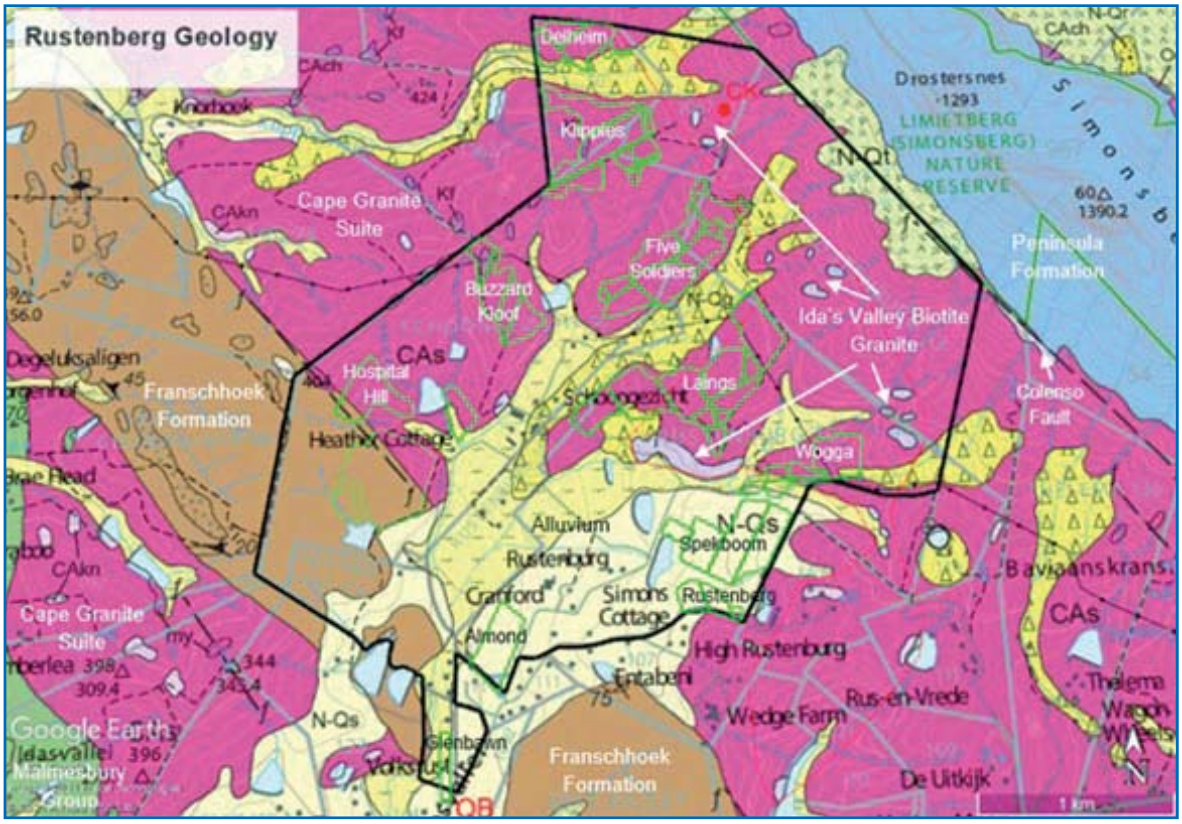
Rustenberg is a wine-producing estate situated in the Simonsberg Valley immediately north of the picturesque university town of Stellenbosch. The Estate comprises some 880 hectares, of which about 150 hectares are planted with active vines, in 10 distinct areas.

The farm has a wine-growing history dating back to 1682, when Roelof Pasman from Meurs, near the Rhine, recognised its wine-growing potential, and by 1781 the farm was producing some 3 000 cases of wine. The farm has had various owners since then, including John X Merriman (after whom their flagship Bordeaux Red is named) and has now been in the Barlow family for 80 years. The farm produces a range of premium red and white wines, the majority of which are exported.

The updated 1:50 000 Council for Geoscience map compiled by J.H.A. Viljoen (2010) and others provides an excellent geological framework for overlaying the vineyards on the geological substrate. Follow-up mapping, fieldwork and photography was conducted throughout the farm to investigate the various geological features on the ground.

The geology of the Simonsberg Valley itself is dominated by the imposing amphitheatre-shaped Simonsberg Mountain, which rises to 1 390 m above sea level, 1 000 m higher than the Malmesbury Group fine-grained quartzites, shales and phyllites that form the rolling hills of the Stellenbosch-Helderberg valley itself. The Simonsberg is shaped like an East Indiaman, sailing to the northwest, and is composed of resistant coarse-grained sandstones and quartzites, measuring 5.2 km in a northwest to southeast direction, and 1.6 km in a northeast to southwest direction. The northwest-trending left-lateral Colenso Fault, which can be traced to Saldanha Bay, is situated at the base of the Simonsberg, and is thought to be the aquifer source for the many perennial "eyes" on the farm.

The rocks of the Simonsberg are gently-folded and saucer-like, with sentinels on each end forming bookends to the mountain itself. At the base of the southeastern sentinel, just above the small town of Pniel, are the remains of a



The geological setting of Rustenberg farm.

The Simonsberg Mountain, looking northeast, with the bedding indicated.

1740s silver mine, started on salted evidence, which consumed enormous amounts of rixdollars as well as senior burgher reputations at the time.[8] This is a story for another day.

Underlying the quartzites, and only mapped on the northeast part of the Simonsberg, are slivers of the shaley Graafwater Formation.

Alluvial scree, comprising angular fragments and sub-rounded boulders of quartzite, is present immediately at the base of the Simonsberg (shown as "N-Qt" on the map), and largely obscures the contact between the quartzite and the underlying granite. The scree is thicker and more extensive on the shallower-sloping northeast side of the mountain.

The highly resistant boulders eroded off the mountain can be seen in the deeply-incised streams and alluvial sediments on the farm property, with the average size and angularity of the boulders decreasing rapidly away from the mountain. Boulders and pebbles found downriver in the Eerste River in Stellenbosch itself are largely composed of rocks eroded off the Simonsberg.

Granites of the Stellenbosch Pluton of the Cape Granite Suite dominate the geology of Rustenberg (shown as "CAs" on the map). The granitic rocks are exposed in many places across the property, mostly on the slopes and terraces between the deeply incised southwest-trending valleys, which demarcate the Krom River and its tributaries. The granites are mostly coarse-grained and are composed almost entirely of milky feldspar, quartz and biotite. The feldspar crystals can be large, up to 5 cm in length.

The Ida's Valley Biotite Granite, interpreted as being emplaced as a later phase into the Stellenbosch Pluton, crops out prominently in a number of places, most notably in a southeasterly trend on the northeastern side of the property. It is possible that the biotite granite is areally more extensive, but is only shown where it has been positively identified in outcrop.

Weathering

Most of the soils on Rustenberg farm are direct and indirect products of deeply weathered granites. The protection afforded by the Simonsberg has allowed deep in situ weathering of the granites, down to depths of 10 m or more.[9]

Hand specimens of a semi-rounded quartzite boulder and of the biotite granite on the Rustenberg property.

Fresh granites contain quartz, feldspar and mica. Feldspar is broken down by carbonic acid from rain, releasing potassium, and mica degrades into chlorite and vermiculite, also releasing potassium. These, in turn, may degrade to form smectites and, finally, kaolinite. Smectites are a group of expanding, water-retaining clay minerals with high cation-exchange capacities. Kaolin, a near chemically inert clay mineral, often used for pottery, may form under severe weathering conditions.

Even after intense weathering, granite-derived soils may retain sufficient feldspar and mica in the coarser fragments to provide a limited supply of residual potassium.

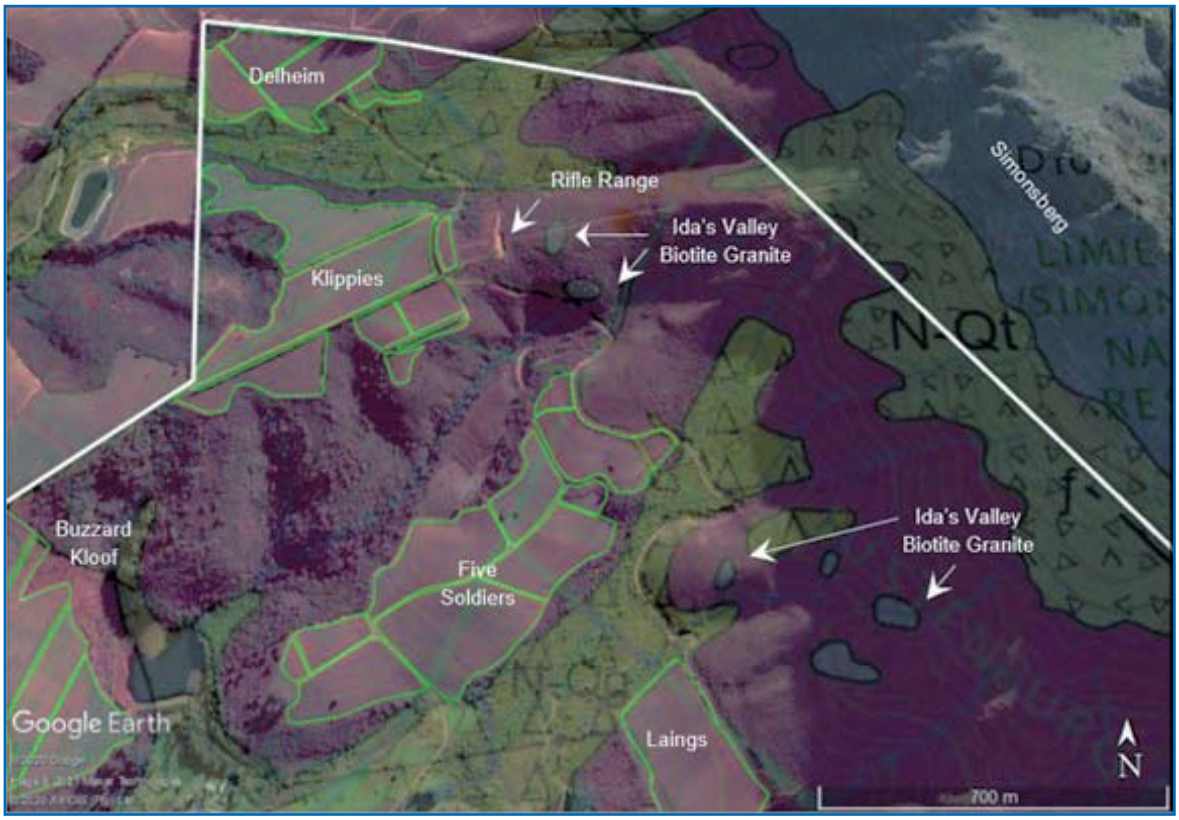
The protection of the iconic Simonsberg quartzitic amphitheatre has allowed for extensive downslope weathering, with some granitic soil profiles measuring over 10 m in thickness. The all-year supply of water has been a significant contributing factor to the overall consistency of quality wine production from year to year.

The deeply weathered granitic profile can be seen in the shooting range close to the Klippies vineyard. The range is an excavation about 110 m long, up to 20 m wide, and from 3 to 5 m deep. The soil profile comprises a 20 to 30 cm-thick layer of dark humus, underlain by a metre-thick iron-rich soft, friable, clayey layer. The reddish colour of the clay layer is assumed to be due to iron re-precipitation in the weathered horizon, in the process known as laterisation.

Below the reddish horizon sits 3 to 5 m of whitish clay, interpreted as due to intense kaolinisation. Relict feldspar crystal outlines can be seen in this whitish clay, as can bulbous, slightly reddish ferruginous zones.

Granite weathering profiles also produce saprolites below the soil profile. Saprolites represent a stage of chemical weathering whereby the granite bedrock has not completed the transition from rock to becoming a soil horizon.

The southwestern part of the farm is dominated by a fault-bounded southeast-trending, 900 m-wide zone of steeply dipping phyllites, shales and fine-grained quartzites of the post-Cape Granite Suite Franschhoek Formation. Soils developed on these rocks are thin (generally less than 50 cm thick), and often gravelly, and



Location of the Rifle Range on the northwestern part of the estate.

Continued on pp.36

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EXPLORING EARTH AND THE SOLAR SYSTEM:

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Are you fascinated by rocks, the Earth, and our place in the Solar System, but wish you knew more of the underlying science? Experts from the School of Geosciences at Wits University have teamed up with Babanango Game Reserve to bring you a unique learning opportunity based in a region of southern Africa with a superlative rock record and open African skies.

This all expenses package includes a 6-day short course, held at the Babanango Game reserve which is part of the African Habitat Conservancy in KZN, will provide participants with knowledge of Earth sciences and astronomy in a region of South Africa with an unparalleled rock record. This offering will not only provide you with a basic theoretical knowledge of Earth sciences and astronomy but will allow you to get up close and personal with a wide variety of ~3-billion-year-old rocks while enjoying walks along the Wit Umfolozi River. This type of immersive experience, where you can investigate and touch the rocks you learn about during lectures, provide some of the most beneficial learning environments. Similarly, evenings will be spent around a campfire stargazing with a resident astronomer, providing you with a hands-on appreciation of the night's sky.

Treat yourself to a getaway in one of South Africa's pristine nature reserves, while learning about rock identification, stars and the processes that shape our Earth and neighbouring planets.

COURSE FEE

The course will run from 26 - 31 July 2021 and will combine daily, short theoretical lectures with many more practical learning opportunities among the unique rock record preserved in the Babanango Nature Conservancy. Each day will involve short lectures in camp accompanied with walks or drives to view important rock outcrops in the region. After dinner, evenings will be spent stargazing around the campfire with a resident astronomer. This accredited course will cover basic and intermediate-level geology and astronomy and all participants will receive certification for this course from the University of the Witwatersrand.

Three meals per day, daily conservation fees, safari-style tented accommodation, course content, as well as for instructions by experts in their respective fields, will be covered in the R8950 per person cost. Exclusions: Personal items, travel to the reserve, additional activities, beverages.

Accommodation in Safari Style Tents, guests to bring their own sleeping bag, pillow, and towel.

Please, ensure you have received PDF directions as google maps do not reflect correctly.

For more information or bookings please email to Dr Grant Bybee at Grant.Bybee@wits.ac.za

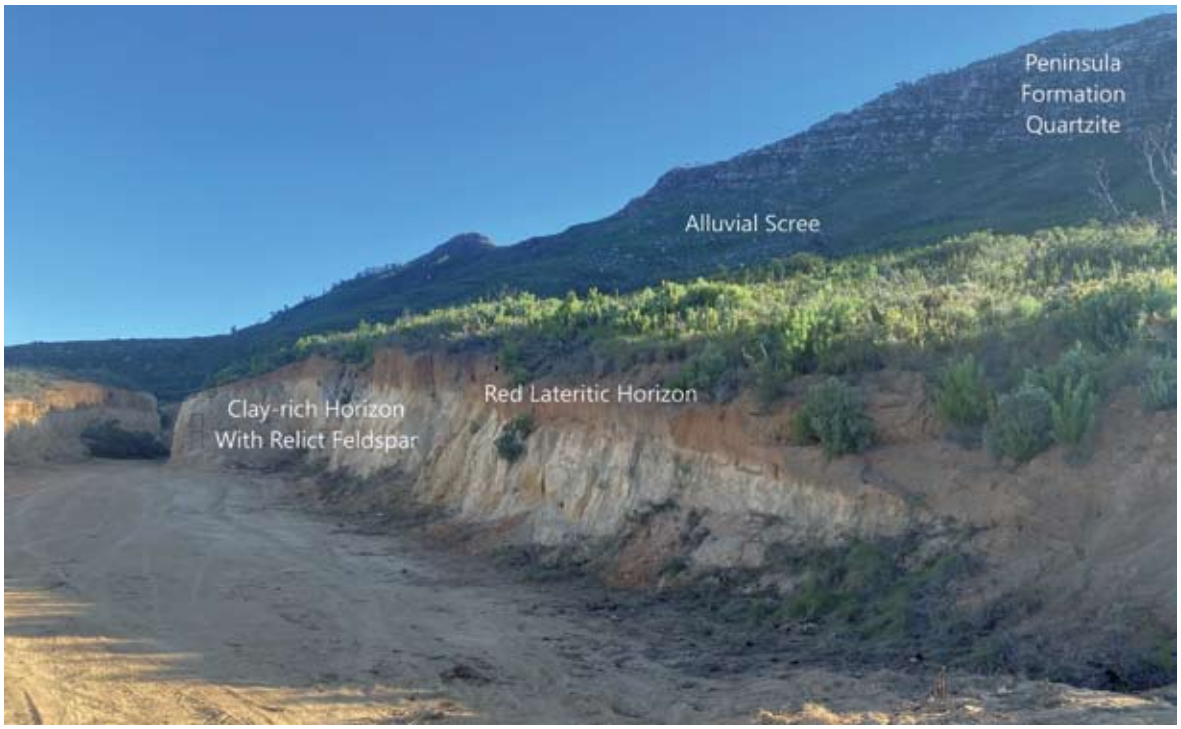
Course numbers are limited to 35 participants.

Please register for the course by completing your details here

Comprehensive Covid-protocols and practices will be in place and all group interaction, including meals and lectures, will be in open air lapa environment.

Participants will need to drive themselves to the Matatane Nature conservancy, ~75 km southeast of Vryheid, for arrival by 3 p.m. on 26 July.

A moderate level of fitness will be required for walks through the Matatane Nature Conservancy and along the Wit Umfolozi River.



The deep granitic weathering profile at the Rifle Range.

are not conducive to vine cultivation. The only vineyards planted on this substrate (Almond, Glenbawn) are where thick granite-derived alluvial soils cover the substrate and associated soils.

Discussion

Rustenberg has several favourable geological characteristics that are shared by a number of the neighbouring estates in the area. These include a mostly granitic substrate, deep weathering of soils, a range of topographical situations, and the presence of perennial water. Most of the vineyards are situated on plateaux and slopes of deeply weathered granite, whereas further down the valley a number of vineyards are planted on transported, mostly granitic-derived, alluvial soils. No vineyards are situated directly on the Franschhoek Formation phyllites.

This variety of situations allows the planting of different rootstocks and varieties on almost a single granitic substrate, with variations in cultivar depending on soil thickness, terrain slope, amount of sunlight and fertilisation needs. This allows the viticulturalist and the winemaker to apply their particular expertise to the making of high-quality premium wines.

Matt Mullins

The full geological report can be found at www.rustenberg.co.za.

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Be the mentor you wish you had!

Bridge the Gap Geosciences Guidance Program (BTG), is a student run organization that focuses on mentorship between undergraduate and postgraduate students as well as students and industry professionals. In addition BTG hosts a number of informative talks, workshops and field trips to expose students and graduates to opportunities and expectations in the work environment.

Earn CPD points through mentoring!

Be the mentor you wish you had and assist in giving some guidance to geology undergraduate and postgraduate students by signing up to be a mentor through BTG. We invite all geosciences/ mining related companies, industry professionals and academics to 'bridge the gap' between university and industry, and to act as positive role models by joining the BTG program as a mentor, sponsor or motivational speaker.

BridgeTheGap
GeosciencesGuidanceProgram
EMPOWER || INSPIRE

If you are interested in getting involved please complete the Google form by clicking on the following link: https://forms.gle/Sf5tMciuSStAQuFL8

Your influence can go a long way in encouraging and shaping aspiring geologists to become future leaders. We believe that each of us can inspire and empower students by being 'the mentor you wish you had'

The program will start in February/March 2021

mineral scene

Pyrophyllite 'Wonderstone' and the 'Cosmic Cannonballs'

Bruce Cairncross
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brucec@uj.ac.za

This Mineral Scene column digresses from the norm as it does not feature a single species, but rather variable minerals, primarily pyrite and goethite. This is the composition of concretions that occur in the Dominion Group pyrophyllite deposit at Gestoptefonein Wonderstone quarry, located approximately 6 km north of Ottosdal in the North West Province. 'Wonderstone' is the commercial name used for pyrophyllite, which has been quarried here since 1937. The mineral has a wide variety of uses, in the synthetic diamond industry because of its thermal and insulator properties, in the manufacture of ceramics, and as an industrial mineral when powdered, in paper manufacture, plastics, paints and rubber (see https://wonderstone.co.za/). Although economic deposits of pyrophyllite are known from other deposits in South Africa, the Ottosdal occurrence is perhaps one of the best known, not just for the product it produces, but also for the concretions that are found within the pyrophyllite.

The 2,700 m-thick Dominion Group consists of volcano-sedimentary strata, predominantly amygdaloidal mafic–intermediate lavas with interbedded sedimentary strata.[1,2] Both successions are exposed at the Wonderstone quarry and the shale is exploited for pyrophyllite, which contains spheres of pyrite that have been studied and are clearly concretionary. However, there is another less scientific tale to these inorganic concretions that leads to esoteric wonder, and extra-terrestrial origins.

The story begins in June 1982 with an article in *Scope* magazine, South Africa's watered-down version of *Playboy*. (That a somewhat geology-related article appeared in such a magazine is baffling). The title of the article was 'Mysteries—the riddle of the Cosmic

A 13.5 cm block of grey pyrophyllite. A round, in situ concretion is present, as is a small cluster on the right, some of which have weathered out leaving the voids. A large weathered concretion (left) has left a spongy box-work residue. The free-standing 3.6 cm concretion in the front displays the typical concentricity and smooth surface. (Specimens and photo: Bruce Cairncross).

A 4 cm concretion sawn in half. The complex radial and concentric growth features are clearly visible. Although not analysed, this is most likely goethite after pyrite replacement. (Specimen and photo: Bruce Cairncross).

Cannonballs' by David Barritt. It described one of the pyrophyllite quarry concretions that was on display in the Klerksdorp Museum. This particular sphere was reputed to be able to move and spin of its own accord. The curator of the museum was astonished to discover that he would place the concretion on a glass shelf in a display case, and the next day, in the locked case, it would have moved to another position. (This was perfectly understandable, considering a smooth, round object, on glass, subject to the slightest disturbance from outside sources such as earth tremors, but that fact was conveniently overlooked). The spheres were therefore deemed unique because:

- They are perfect spheres, something said to be unnatural [not so];
- They occur only in one mine in South Africa [not so];
- They have a sponge-like structure in their core [correct, some do, due to weathering];
- They are composed of different material to the host rock [correct, as are most concretions].

And this was important:

- They had supernatural powers [!]

Some of these "facts" then led to the concretions assuming almost a cult-like status, particularly among the esoteric

A relatively unaltered pyrite concretion. The bluish tinge is an artefact of the artificial lighting. (Specimen and photo: Bruce Cairncross specimen).

crystal collectors and psychics. So much so that a few years after the *Scope* article, the SABC TV programme '*50-50*' produced a programme on the "mysterious objects". In typical sensationalistic fashion, the interviewer laid the foundation for the programme by explaining the "untold mysteries" of these spheres and how the 50-50 team were going to solve this puzzle. To their credit, they did interview the then head of the Geology Department at the RAU, Dirk van Reenen, who provided a totally plausible, and correct, geological interpretation of these concretions, but for the rest of the show, his explanation was totally ignored! Then, a rather gypsy-like psychic was questioned and she proceeded to explain that these circular, metal objects were unique. They were the remains of space ships (ball bearings?) that had landed in South Africa millions of years ago and became entrapped in the rock. Furthermore, if you sliced the sphere in half (see figures), it would contain a microchip with an encoded message from the aliens. This message would reveal all the secrets of interstellar travel. Unfortunately, or perhaps conveniently, the psychic in question did not have the apparatus with which to decode the message! At the end of the programme, the interviewer reiterated his opinion that these were indeed totally baffling objects and we would never understand their origin.

While the above is amusing, there were financial spin-offs. Because of the publicity, the pyrophyllite concretions became highly collectable among a certain sector of the population, and the concretions, if they were available, started assuming expensive price tags. There was even a stage when, via the internet, some entrepreneurs started peddling the concretions to certain gullible individuals, whereby they could be honoured to temporarily become "The Keeper of the Sphere" for a certain duration, after which they relinquished this privilege to the next person who would then receive it and pay his fee. Obviously, this honour only happened once the necessary "keeper's fee" had been paid. *Caveat emptor.*

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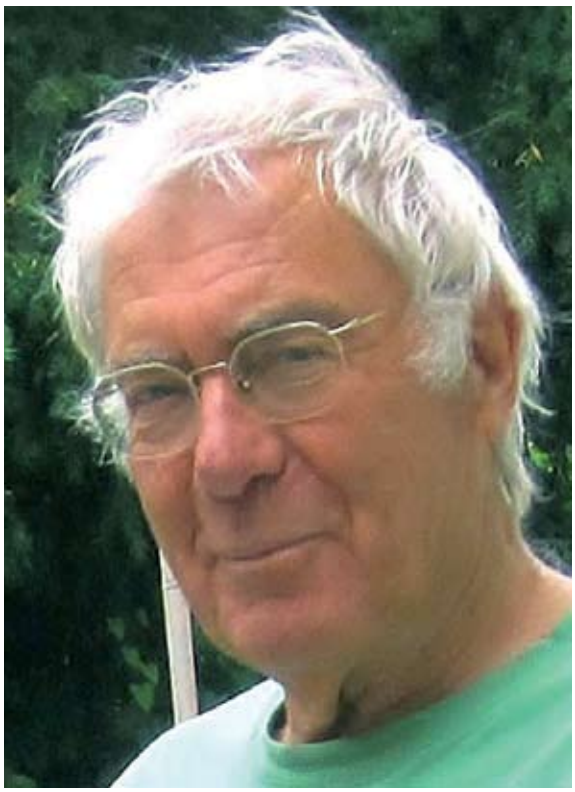
A composite 5.3 cm concretion. Not all are single and rounded. (Specimen and photo: Bruce Carincross).

obituary

Dietrich Dankwart Klemm †

Dietrich Dankwart Klemm
29 January 1933 to 2 October 2020



Prof Dietrich Dankwart Klemm in 2012, in his garden in Diessen

Prof. Dr Dietrich Dankwart Klemm (Dietrich or "DD" as some of us knew him), was passionate about South African geology and mineral deposits and the building rocks of ancient Egypt. For most of his academic life he was Professor at the Ludwig Maximilian University (LMU). His grandfather, Carl Albert Gustav Klemm, was a well-known geologist and director of the Grand-Ducal Hessian State Geological Institute. Dietrich's father, Dr Ing. Richard Klemm, was a chemical engineer. Although he never spoke much about his childhood, Dietrich was proud of his scientific heritage and followed in the footsteps of his grandfather, working as a young lecturer in the Odenwald and for the Geological Survey of Hessia.

Dietrich Klemm studied at the universities of Frankfurt (BSc geology) and Heidelberg (mineralogy), where he received a doctorate in 1959 with a thesis on the Fe deposit of Divrik, Turkey (under Paul Ramdohr). He moved to the Ludwig Maximilian University of Munich and he received the habilitation (DSc) in 1964, and became full professor of geochemistry and economic geology, in 1973. Until his retirement in 1998, Prof. Klemm was a highly respected teacher at the LMU and became a very successful scientist, well-funded by the German Research Foundation (DFG), with over 50 project applications, the Volkswagen Foundation and other sources, by securing over 10 million Euros for research. His colleagues and students profited tremendously from this funding and participated in exciting research and field expeditions.

Dietrich worked on Precambrian sedimentary deposits and BIF-related iron and manganese ores of South Africa, on the Bushveld Igneous Complex (BIC), and the Great Dyke mineralisation in Zimbabwe. He was fascinated by gold deposits and was also active in investigating mineral deposits of Nigeria and of southern (alpine) Europe.

Together with his wife Rosemarie Klemm, a well-respected archaeologist and Egyptologist, Dietrich investigated the cultural heritage of ancient Egypt and Nubia and how it was based on the rock and mineral wealth of the North African region. This co-operation with the Egyptian Organisation of Antiquities on ancient monuments led to the development of a scientific laboratory for restoration and conservation of building materials and fruitful teamwork with the Bavarian Office for Conservation of Monuments. Prof. Klemm's interest in archaeometry and conservation of monuments resulted in new investigation methods and helped many of his students and colleagues to become specialists in these disciplines. After his retirement, Prof. Klemm was still active for several years in conservation and archaeometry, with one of his daughters.

I first met Prof. Klemm during his sabbatical at the University of Stellenbosch, where I was a post-doctoral researcher, in 1990. Actually, it was my wife (then a PhD

☞

student in biology) that met him first and brought him for a dinner. He was a gentleman and charmer. On excursions he used to pick flowers on the outcrop and give them to female students before giving field explanations, and he often wore a bow tie during mine visits (even in the heat of the Bushveld). He was always interested in a cultivated conversation on almost any subject in the world. But he was selective in his conversation partners and offered the German "Du" (you) only after he knew people very well, otherwise rather using the respectful but distancing plural form of addressing ("Sie"). It was an honour to have him as promoter and a friend. I worked under him at the LMU for many years until his retirement and my habilitation dissertation. At the same time, Prof. Pat Eriksson of the University of Pretoria also did his habilitation degree under the auspices of Dietrich Klemm.

Dietrich Klemm initiated and supervised over 100 MSc and 40 PhD dissertations. The many student excursions organised together were highlights of the LMU geology curriculum. Most famous across Germany's geology departments were the 2–3 week-long excursions to South Africa organised by Prof. Dietrich Klemm every two to three years. They took about 20 German students across the mines, visiting daily one or even two underground and open-cast operations, and on weekends, spectacular world heritage outcrops, including the obligatory one-day drive through the Kruger National Park. In those days, the South African mining companies generously covered much of the expenses of such excursions and were magnificent hosts of the class in their hostels and at impressive dinners and lunches. Among Dietrich's students were many members of the "German Mafia" within the South African geological fraternity, such as Hannes Henkel (one of the oldest) or Wolfgang Mayer and Robert Kiefer (among the youngest). For the colloquium in celebration of his 65th birthday, organised by Dr Esther von Plehwe-Leisen and myself (1998), we counted 16 former students of Dietrich who became professors, later working and living between Asia, Africa, Europe and South America.

Prof Klemm's important publications include:

- A book edited with H.-J. Schneider, "Time- and strata-bound ore deposits" (Springer, Berlin 1977; 1984; ISBN 3-540-08502-5 and ISBN 0-387-08502-5), which was a "must-read" when I was a student in Berlin, where Schneider was my economic geology professor.

Books with Dietrich's wife Rosemarie Klemm (Klemm, DD and Klemm, R) include:

- 1981:"DieSteinederPharaonen.Herkunftsbestimmung altägyptischen Steinmaterials", published at the Staatliche Sammlung Ägyptischer Kunst München.
- 1993: "Steine und Steinbrüche im Alten Ägypten", Springer, 1993 ISBN 3-540-54685, 465 p.
- 2008: "Stones and Quarries in Ancient Egypt", British Museum Press, London, 354 p.
- 2010: "The Stones of the Pyramids. Provenance of the Building Stones of the Old Kingdom Pyramids of Egypt", de Gruyter, Berlin, ISBN 978-3-11-022123-7.
- 2013: "Gold and Gold Mining in Ancient Egypt and Nubia/Sudan", Springer, 649 p.

These books became standard work in Egyptology. Dietrich Klemm was also the Editor of the Springer journal Mineralium Deposita, affiliated to the Society of Geology Applied to Mineral Deposits and a long-time member of the Geological Society of South Africa.

Prof. Dr Dietrich Dankwart Klemm passed away peacefully on the 2nd October 2020 in his house in Diessen, close to Munich. We commiserate with his family, wife, three daughters and grandchildren and great grandchildren, his students and colleagues and all those that knew and miss Dietrich.

Wlady Alterman
University of Johannesburg

obituary

Derek Nigel Robinson †

Derek Nigel Robinson
18 February 1942 to 30 October 2020

Derek Robinson and his twin Michael were born in Scottburgh on the KwaZulu-Natal south-coast in 1942, and completed their schooling at Amanzimtoti Primary and Kingsway High Schools in 1961. Thereafter Derek pursued a four-year BSc Honours degree in Geology at the University of Natal (Howard College, Durban) graduating in 1965, followed by an MSc (Geology) in 1971.

He was awarded a PhD by the University of Cape Town in 1979 for his outstanding study on diamonds, and thereafter completed a MDP (Management Development Program) at the UNISA School of Business Leadership in 1980.

Derek started his career as a field geologist with Sasol in the latter part of the 1960s, working in the Natal midlands and foothills of the Drakensberg Mountains. He thoroughly enjoyed this work and his field mapping experiences, and being a very keen fisherman tested many a trout stream on his days off in the foothills of the Drakensberg.

He married Melody Nash in 1970 and together they raised two sons, Shaun and Martin, who like Derek enjoy their golf and are both settled in the UK with their families.

After returning to the University of Natal in 1971 to complete his MSc, he joined the Anglo American Research Laboratory (AARL) as a geologist in the same year, quickly establishing himself as an excellent mineralogist, and soon thereafter a diamond specialist.

The AARL diamond connection

In 1974, the mineralogists at AARL were divided into different groups to support the main commodity focus of the Anglo American and De Beers Group of Companies. Within the De Beers Diamond Division a Kimberlite Research Group was created under the leadership of Dr Bobby Danchin, and Derek rapidly established himself as a knowledgeable senior member of this specialist group.

A young Derek on his first trip to London in 1971.

Derek continued his interest in the study of diamonds, and in particular the many different surface textures and etch and growth features on diamonds from kimberlites. He also pioneered the study of diamonds from many alluvial deposits along the Orange and Vaal rivers, documenting their abrasion features. His initial detailed studies of diamonds from southern African primary and secondary sources soon spread to other parts of Africa and countries such as Australia, Brazil and Canada, where De Beers were searching for new mines. As his expertise and skills became more widely recognised, he was frequently requested to examine diamond parcels from other companies involved in worldwide and local diamond exploration.

Derek was also instrumental in the purchase and installation of a Jeol JSM-35 Scanning Electron Microscope (SEM) for the AARL to facilitate his studies into diamond surfaces. This research instrument allowed him to document in detail diamond characteristics from many different kimberlites worldwide. For this work he obtained his PhD from the University of Cape Town in 1979. He also spent many hours documenting mining- and processing-related diamond breakage and trained a team of diamond-observers at Harry Oppenheimer House (HOH) in Kimberley to undertake these studies on behalf of De Beers mining, prospecting and evaluation activities. This work also proved important in the progressive modification and improvements to kimberlite-ore comminution and processing technologies to reduce breakage and improve diamond revenue streams.

Aside from undertaking extensive studies on diamond populations from many hundreds of kimberlites, and kimberlite diamond mines, Derek undertook detailed research on alluvial diamonds from many different diamond mining sites and alluvial diggings within South Africa and along the Namaqualand and Namibian coast (West Coast deposits). This work led to the characterisation of distinctive diamond populations, which allowed him to postulate that the probable primary source or sources of diamonds from these alluvial areas were the diamondiferous kimberlites around Kimberley and/or the alluvial diamonds in the Transvaal basin. This postulation was subsequently confirmed after isotope work on minerals included in alluvial diamonds both from the interior and the coastal deposits indicated that Kimberley diamonds were a principal source for the west coast diamonds.

Internationally recognised diamond expert

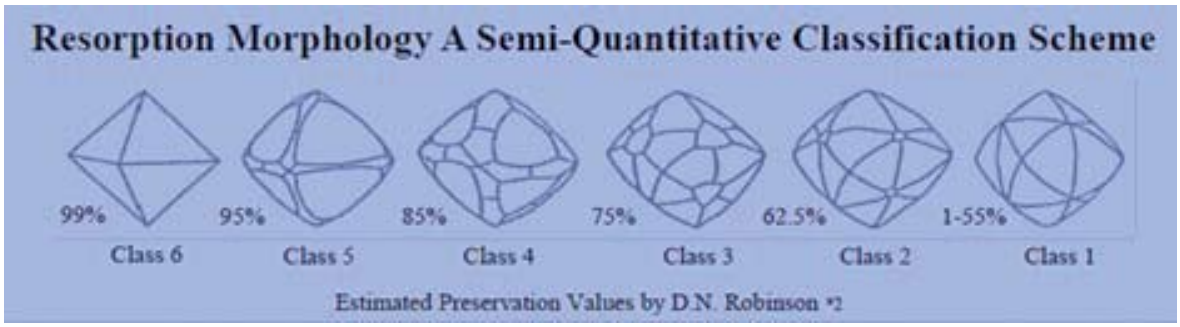
From the outset of his career, Derek's hallmark was his professionalism, systematic approach to diamond studies, and powers of observation. He was highly respected by his superiors and colleagues within the Anglo American and De Beers stable, and local and international peers. He attended many of the early International Kimberlite Conferences in various parts of the world, where he delivered numerous scientific papers on diamonds and diamond exploration methodologies.

As a scientist, Derek was passionate about his work and research on diamonds, and meticulous and uncanny in respect of his observations, attention to detail, and interpretation of the formation and resorption of these unique minerals during their primary mantle and kimberlite formation and volcanic emplacement at the Earth's surface. In addition, he extended his research to the transport of diamonds, further documenting their abrasion characteristics, and reworking in alluvial or secondary settings, thereby providing further important insight for regional exploration programmes.

Close colleagues such as Jeff Harris, Owen Garvie, Paddy Lawless, Andy Davy, Barbara Scott Smith, Steve Haggerty, Jock Robey, Craig Smith, and many others who spent time or worked with him, have all commented about the many positive exchanges, and interminable discussions about diamonds when working together at the AARL (in Johannesburg) or in HOH (in Kimberley).

Sometimes these extended discussions would get rather rowdy, but a beer either in the Booysens Hotel (southern part of Johannesburg) or the Kimberley Club bar inevitably re-established the equilibrium. Though always firm about his views, Derek was polite, a pleasure to be in the company of, had a ready smile, would willingly share his immense knowledge, and was particularly helpful and supportive of new young graduates and other scientists working in diamond and related disciplines.

Derek's visits to Edinburgh to undertake and complete diamond studies in collaboration with Dr Jeff Harris (Senior Research Fellow and Diamond Expert, at the University of Glasgow) became the stuff of legends. Arriving on the doorstep of Jeff's home in Edinburgh, he first queried why the front door was always open and whether it was safe to leave diamonds out under a microscope while both experts went out for an extended pub-lunch—always the careful scientist!



It is over 40 years since the submission of Derek's PhD thesis, for which Jeff Harris was the external examiner, yet his work and findings are still used internationally both in diamond exploration and by students having to describe diamonds for higher degrees. His detailed observations of diamond surface features are as relevant now as they were when first documented in 1979. There are few PhDs that have stood such a test of time and Derek's work has left a legacy that is as relevant today as it was at the time of preparation and completion.

In the 1970s, Derek together with Jeff Harris developed a diamond resorption model, shown above, which is still used today with minor modifications.

In 1998, with the split of Anglo and De Beers, the AARL was divided into two sections, namely the Analytical & Metallurgical Laboratories, and the Geoscience Centre (GSC), the latter focusing on applied Diamond Exploration. At that time Derek was promoted to Senior Research Fellow, a position he retired from in 2001 to spend quality with his wife Melody, his two boys and their families, and his beloved game of golf.

Family man and avid golfer

Derek was a devoted family man and lived with his wife Melody in Winchester Hills in southern Johannesburg for over 40 years, before moving to Jeffreys Bay. Melody was a dedicated school teacher and they raised two successful sons, Shaun and Martin.

Derek with grandchildren and sons Shaun (middle), Martin (far left) and their wives (April 2012).

Derek about to tee off at Glenvista Golf Club in 2017, aged 75.

Derek thoroughly enjoyed golf, initially being a dedicated supporter of the Crown Mines Golf Club and then subsequently his closer-to-home Glenvista Golf Club. At Glenvista he served as a conscientious committee member and ran their Junior Golf League for several years. He has been quoted as saying that he retired early so that he could play golf five days a week. Not surprisingly, because of Derek's watchful eye and coaching, both Shaun and Martin are good golfers.

As remembered by Paddy Lawless, one of Derek's favoured methods of making pocket money was to play 'yardage' during his golf games. This means that if the hole being played was about 450 metres from the tee, the amount of money wagered on the hole was typically 450, usually rands. Many golf courses are 6 500 metres long, so if a fellow golfer was playing badly it could be an expensive day! Derek played this with well-matched partners and opponents and was good enough not to have to pay out except on a few occasions. He had a 'stiff' swing that was not particularly attractive to watch but nevertheless most effective.

Derek receiving another trophy at Glenvista Golf Club in 1991.

Accomplished fisherman and story-teller

He was also a very keen and accomplished fisherman and often shared experiences about salt-water fishing with his twin brother on the Natal coast near their boyhood home in Amanzimtoti, and elsewhere in later years.

Derek was always good for a story, an example being some hilarious tales about the installation of the first Jeol Electron-microscope at AARL, and his interactions with the Jeol installation technician whose English was considerably better than Derek's non-existent Japanese, or rather 'Japinglish'. To hear Derek describe and imitate the accent and terminology of the Japanese technician responsible for installing the new machine was hilarious. One particular story was about a dent in the Jeol housing and Derek asked the technician how this could or should be repaired. He could not understand the answer because of the pronunciation, which sounded something along the lines of 'hahhaharaash'. What the Japanese technician was trying to say was "car garage" and was recommending normal panel beating to address the damage.

Derek had few weaknesses, but the few he had provided considerable amusement among his colleagues. According to Paddy Lawless, Derek was a smoker and serious snorer, while Paddy also snored and smoked. These two often shared a room on overnight trips and meetings, and apparently seldom disturbed each other! Equally, Derek was not the most organised traveller and more than one of his work colleagues have commented that if possible it was not wise to travel with Derek if you could help it.

A typical example, highlighted by Jock Robey, was Derek 'losing' his passport in Moscow's main airport at the end of a trip to Russia. After frantically searching for it, someone found and handed it in to uncompromising airport authorities at the very last minute so that the two De Beers geologists, by then sweating blood, could depart the country and an uncertain fate!

Publications, Articles, and Reports

Derek completed his PhD on 'The surface textures and other features of diamonds' at the University of Cape Town in 1979. The importance and longevity of this high-quality study has been commented on above, as has the work done with Jeff Harris of the resorption morphology of diamonds.

He authored and co-authored some 27 peer-reviewed papers in Kimberlite Conference Proceedings and international journals, wrote many internal company reports, abstracts and articles, and was a regular speaker and participant at local and international diamond conferences.

His legacy

Derek's pioneering diamond work set an unrivalled contribution to the understanding of diamond paragenesis, particularly diamond formation and resorption in the mantle and kimberlite volcanic emplacement. Most notably, his work continues to be referenced by numerous international scientists and researchers in the field of diamond exploration and mining, kimberlite, lamproite and mantle studies, and the origin and transport of diamonds.

The memories of the many positive and stimulating times that his numerous colleagues and friends experienced in his company in the work environment at AARL and De Beers, golf courses and fishing waters he frequented, and family situations, will be fondly remembered by all.

Most of all his honesty, frankness when required, ethics, teamwork, humour, smile, and particularly his positive approach to life, family, friends, and colleagues, will not be forgotten.

And as so aptly expressed by his son Martin, "I was honoured to have Dr Derek Robinson as my father. Definitely the most humble and kind man I've ever known. He is sorely missed in both the geology and golfing fraternities."

Rest in Peace, Derek.Compiled by J**ohn Bristow, Owen Garvie, Jeff Harris, Paddy Lawless, Barbara Scott Smith,** and **Assie van der Westhuizen,** with contributions from +40 of Derek's colleagues, associates, and friends, which are acknowledged and greatly appreciated.

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

regret to announce:

EVENT POSTPONED

Dear Southern African Earth Sciences community,

As many of you by now well know, the current global Covid-19 pandemic, which grips the world in its virulent claws, has led the Geocongress Local Organising Committee (LOC) to make the difficult (but we believe correct) decision to postpone the 2020 Geocongress. The committee continues to monitor the local and international situations, and has as yet not made a definite decision regarding the exact dates over which the postponed Geocongress will be held. Our preliminary feeling is that the event will run in June/July 2021 and that it will comprise a significant component of online or remote-access functionality.

The LOC would like to apologise for any inconveniences that this postponement may have caused, and would like to thank each and every one of the session chairs for their efforts thus far. At this point, the theme and proposed sessions will carry over to next year, the website will remain live, and the abstract submission portal will continue to accept abstracts. The event website (http://allevents.co.za/geocongress/), the Geobulletin, and the GSSA mailing list will remain the primary vehicles for communication of updates related to the postponed Geocongress. As always, we will look forward to welcoming everyone to Stellenbosch once it is safe to do so.

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!

Mountains of the Moon, Shrinking Icefields and Tropical Forests

THE GEOTRAVELLER

By Roger N Scoon*

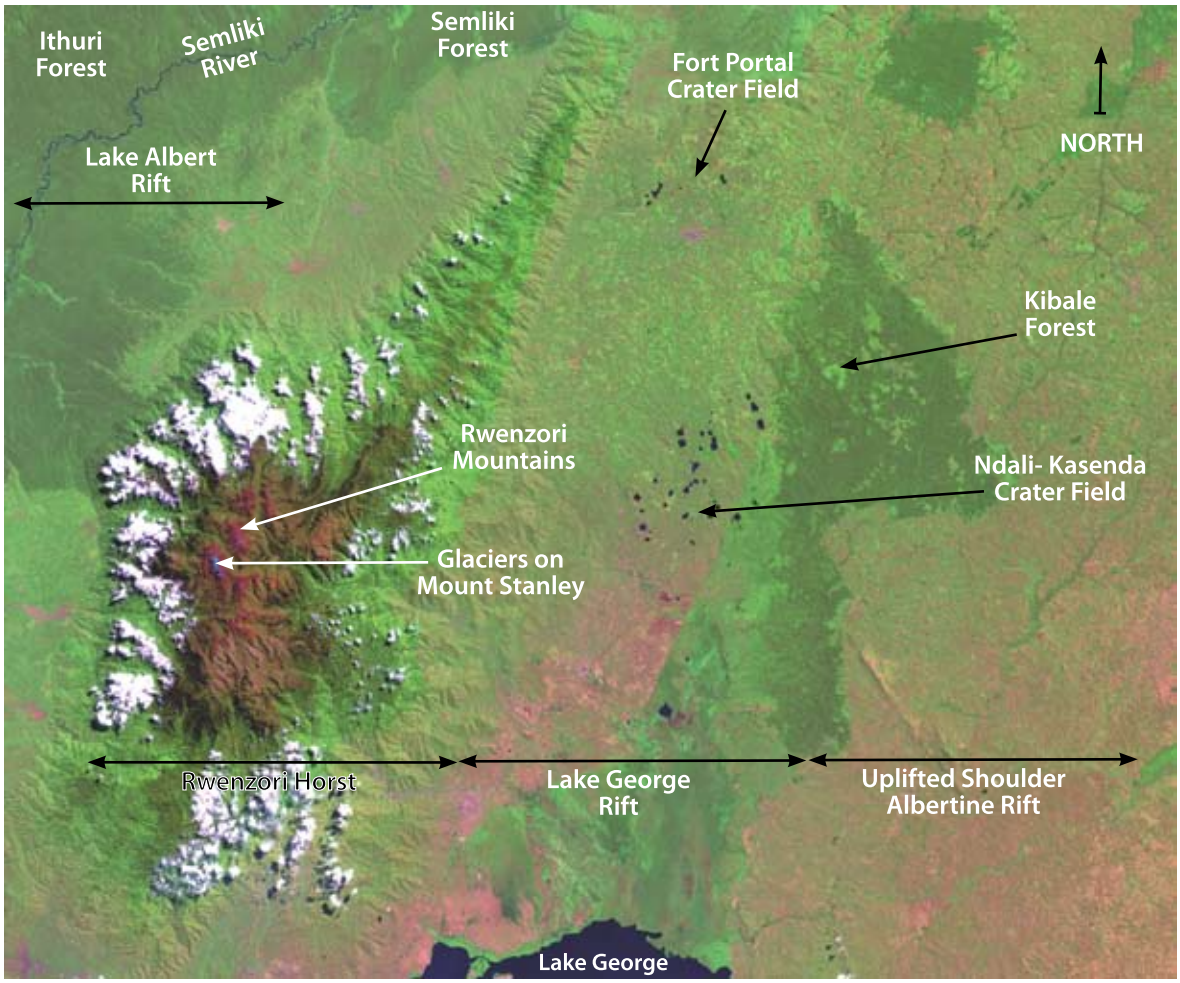
Rwenzori Mountains and Semliki National Parks, Uganda:
Mountains of the Moon, Shrinking Icefields and Tropical Forests

The Rwenzori Mountains and Semliki National Parks are in a remote region of western Uganda. The Rwenzori (or Ruwenzori) is a range of mountains that contains six large massifs with heights of over 4500 m. Several of the peaks are sufficiently high as to contain small glaciers. Mount Stanley (5109 m), the third highest mountain in Africa, transects the international boundary with the Democratic Republic of Congo (DRC). The highest peak of Margherita is in Uganda, and the second highest summit, Alexandra (5091 m), is in the DRC. The Semliki (or Semuliki) National Park is in a low-lying, thickly forested section of the Albertine Rift. The principal geographic feature is the 140 km-long Semliki River, which flows north from Lake Edward, skirts the western side of the Rwenzori, and drains into Lake Albert.

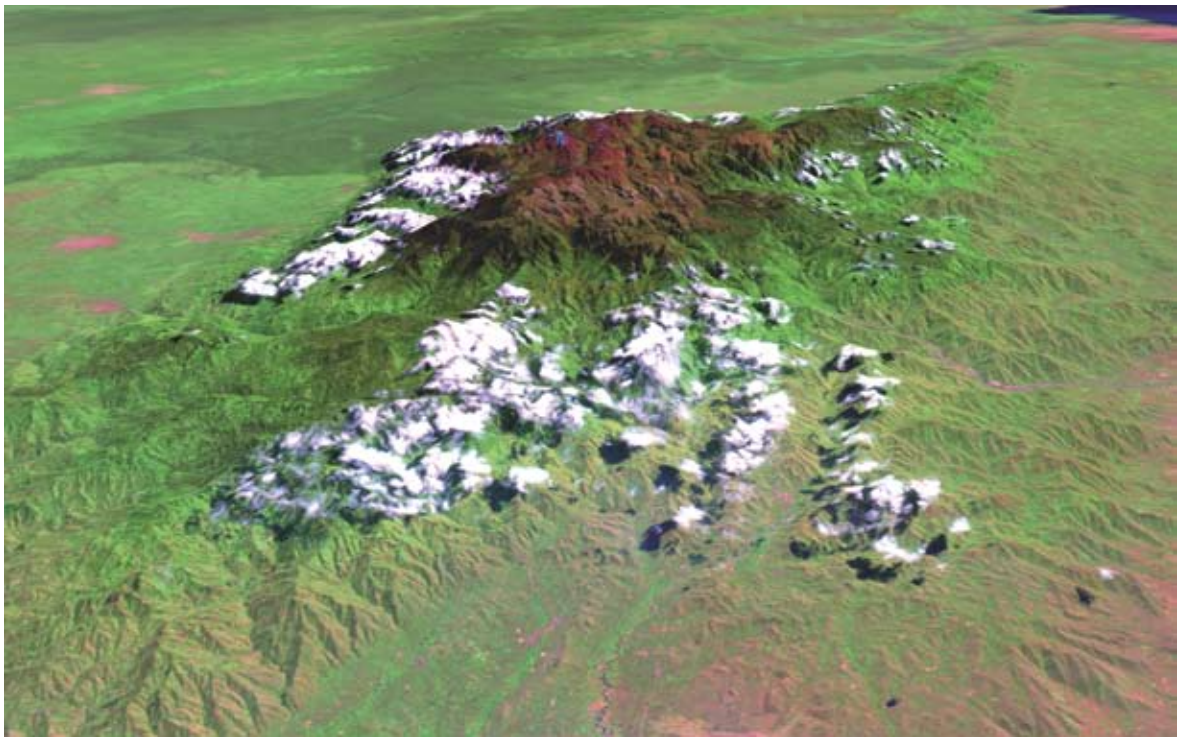
*The Rwenzori Mountains are generally thought to be the legend underlying the descriptions of the '**Mountains of the Moon**', i.e., the snow-capped peaks in equatorial Africa described by the Roman geographer Ptolemy (in approximately 150 AD). This informal description is still used, and the occurrence of snow-capped peaks located almost on the Equator is remarkable. The Rwenzori Mountains contain a tremendous diversity of flora and fauna, the unusual nature of which can be appreciated from descriptions of a "cool, moist island rising from the dry tropical plains".[1] This unusual setting (noting that the tropical regions were relatively dry during the Late Pleistocene) has "encouraged the development of a unique variety of animals and plants, including numerous endemic species".[1]*

The Rwenzori Mountains were for many centuries thought to be the source of the Nile River, and although this is now known to be in part inaccurate, the localised high rainfall and equatorial snow melt does contribute to water fed

View of the Rwenzori Mountains with unique flora of the upper heathlands and moorlands in the foreground (source: Wikipedia.org).



Satellite image showing the position of the Rwenzori Mountains in the centre of the Albertine Rift. The mountains are associated with a large horst block located between two branches of the Albertine Rift. The Lake George Rift peters out northward, but the Lake Albert Rift, which contains the Semliki River, is a persistent feature on the western side. Small lakes associated with crater fields are visible to the east of the Rwenzori. The dark green areas are associated with dense tropical rainforests (in the Semliki Valley and Kibale NP) and Afromontane forest on lower slopes of the Rwenzori. (Source: Copernicus Sentinel-2B MSI image (acquired 7 Aug 2018) processed by Philip Eales.)



3D satellite image of the Rwenzori Mountains. Small patches of blue are mostly permanent icefields but with some snow-covered areas. (Source: Copernicus Sentinel-2B MSI image (acquired 7 Aug 2018) processed by Philip Eales.)

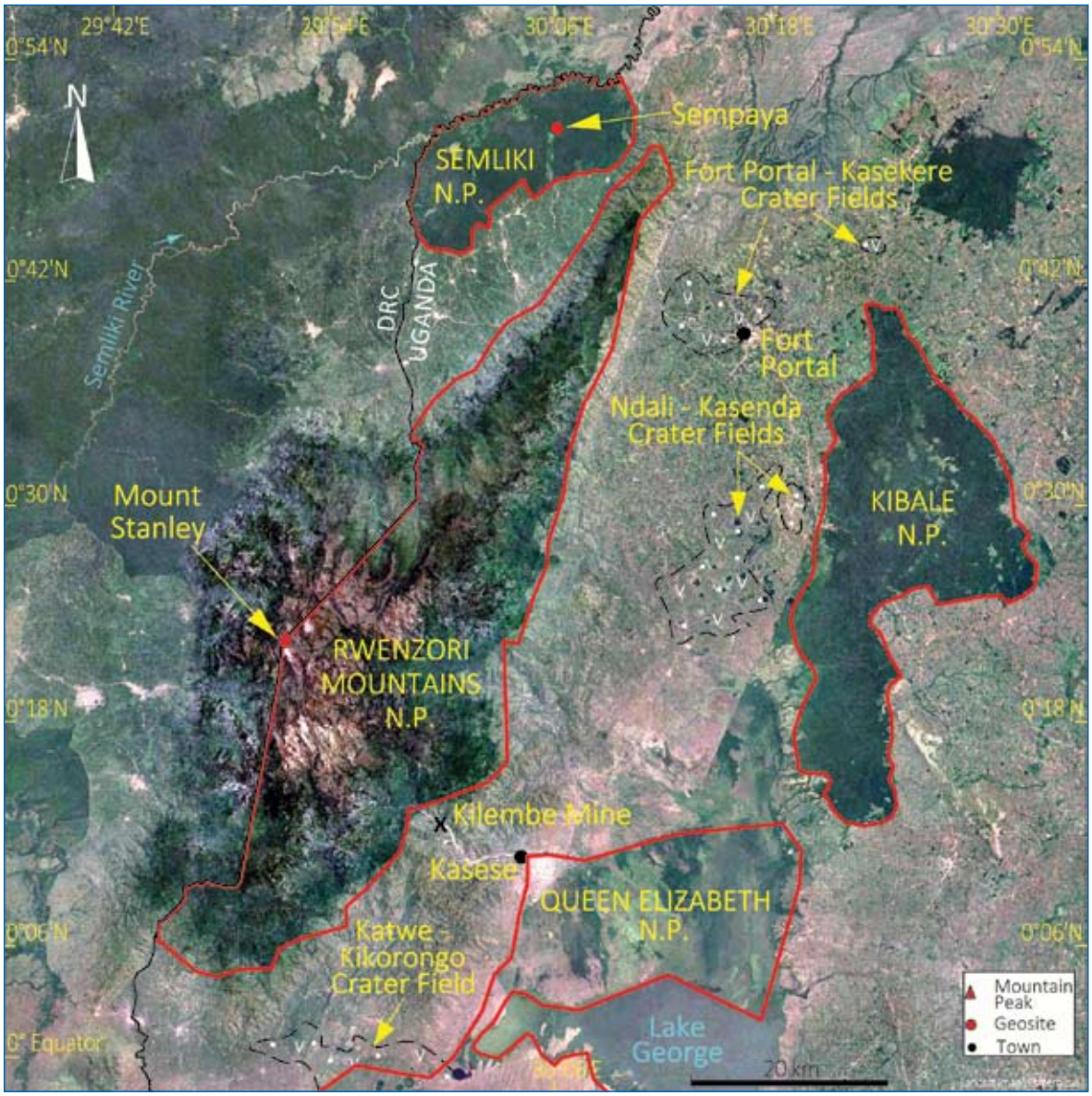
The Rwenzori Mountains form an imposing rampart on the western side of the Lake George Rift, as seen from the Ndali-Kasenda Crater Field.

into Lake Albert. The Semliki River is, however, a subsidiary source of the Albert Nile, as the bulk of the flow is provided by the Victoria Nile. The first Europeans to report on the mountain range were members of Stanley's expedition that crossed the Congo forests in 1888. The name 'Ruwenzori' was recorded as meaning 'rain or cloud maker' in the local language of the Bakonzo people. The mountains were first climbed in 1906, by members of an Italian expedition led by Luigi da Savoia. The "Guide to the Rwenzori: Mountains of the Moon" by Henry Osmaston[2] is a valuable reference for historical and background information. The equatorial setting and wet climate results in the mountains being obscured by mist and clouds. The daily clouds may, however, clear at sunset to afford unforgettable views.

The Rwenzori Mountains and Semliki National Parks are accessed from the regional towns of Kasese and Fort Portal. Fort Portal is 300 km from Kampala and the travelling time is approximately 5–6 hours. The roads from Fort Portal and Kasese to the park entrances are unsurfaced. The western part of the Rwenzori Mountains is protected in the extensive Virunga National Park, DRC (this does not form part of this contribution). The location of the Rwenzori Mountains and Semliki National Parks is shown here in a Google Earth image. This image also depicts the Kibale National Park and the northern part of the Queen Elizabeth National Park. The latter occurs in the rift valley; Kibale is located on the uplifted eastern shoulder. Large parts of this region are thickly forested. Tropical rainforests dominate the Semliki and Kibale National Parks, with luxuriant Afromontane forest on the lower slopes of the Rwenzori Mountains.

The Rwenzori Mountains are associated with ancient metamorphic rocks confined to a horst block in the Albertine Rift. The horst is located between two branches of the rift: the Lake George Rift and the Lake Albert Rift. The Albertine, or western branch, of the East Africa Rift System (EARS) is a Cenozoic phenomenon with an estimated maximum age of 30 Ma.[3,4] The rift propagated southwards and extends from Sudan to Mozambique. A characteristic feature is the occurrence of multiple horst blocks within the rift. The rift valley can be envisaged as a sequence of mostly half-grabens, each of which contains a large finger lake.

All other high peaks in East Africa, including the snow- and ice-capped summits of Kilimanjaro and Mount Kenya, are associated with either free-standing or coalesced volcanic cones. Volcanism is an interrelated feature of continental rifting and the region east of the Rwenzori contains several crater fields. The crater fields are, however, the only expression of volcanism in this section of the Albertine Rift, as the active volcanism of the Virunga Mountains occurs much farther south.



Google Earth image showing the extent of the Rwenzori Mountains, Semliki and Kibale National Parks, Uganda. The western section of the Rwenzori is protected in the Virunga National Park, DRC (area not shown). Mount Stanley (5109 m), the highest of the six main mountains, transects the international border. The Rwenzori Mountains area is associated with ancient metamorphic rocks. Volcanic rocks are restricted to localised crater fields. The hot springs and geyser at Sempaya attest to the presence of geothermal heat in the rift valley and some faults may remain active.

The Nyinambuga Crater in the Ndali-Kasenda Crater Field contains a small freshwater lake.

The Rwenzori is a mountain range with a length of 120 km and a maximum width of 50 km. It is the world's highest rift-related mountain range (other examples of uplifted mountain ranges are the Tetons and Sierra Nevada). In the case of the Rwenzori, the mechanisms and age of the uplift are still debated. The six massifs with elevations of over 4500 m are as follows:

- *Mount Stanley (5109 m), Uganda/DRC;*
- *Mount Speke (4890 m), Uganda;*
- *Mount Baker (4843 m), Uganda;*
- *Mount Emin (4797 m), DRC;*
- *Mount Gessi (4715 m), Uganda;*
- *Mount Luigi da Savoia (4627 m), Uganda.*

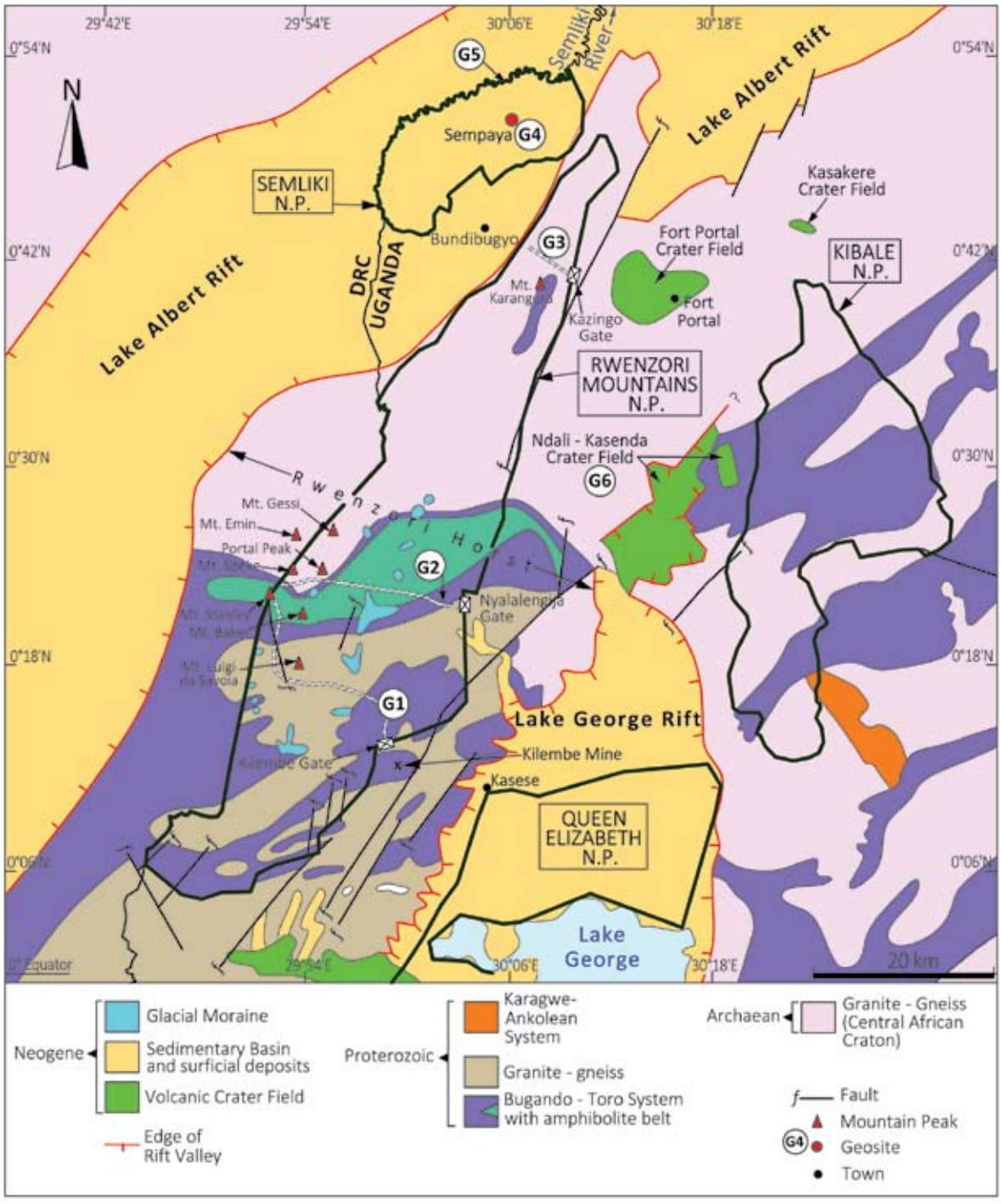
There are numerous subsidiary peaks in the Rwenzori with heights over 4000 m. These include the Portal Peaks (4370 m) in the northern part of the central peaks, an area that includes some of the best views of the higher summits. Each massif is separated by rugged landforms with deep gorges and the main summits involve technical ascents.

When first viewed by Europeans, icefields covered all six of the massifs and included 44 named glaciers, mostly cirque glaciers and summit ice caps (slope or valley tongues were rare).[5] Photographs from this period by Vittorio Sella provide important historical details. The icefields are estimated to have covered an area of 5-7.5 km². The Vittorio Emanuele Glacier (0.48 km²) and the Speke Glacier (0.375 km²) on Mount Stanley were probably the largest individual features. Relicts of the small icefields and glaciers are currently restricted to the summits of the three highest mountains, Mounts Stanley, Speke and Baker. The ascents of Margherita Peak and Alexander Peak on Mount Stanley include crossing some of the remaining glaciers.

*The **Rwenzori Horst** is dominated by two broad geologic systems.[2,6,7] The northern part (together with the eastern rift shoulder) consists largely of granitic gneiss, which is part of the Central Africa Craton. This component of the craton, which is informally known as the Uganda Gneiss Complex, has an approximate age of 2750–2550 Ma (data reviewed by Dirks et al.[8]). The central and southern part consists of metamorphic rocks assigned to the Buganda-Toro System, a Palaeoproterozoic mobile belt (estimated age of 2200–2100 Ma) that is correlated with the Ubendian*

"Climbing toward the twin peaks of Alexandra (left) and Margherita (Mount Stanley) on the Kilembe Trail, Rwenzori Mountains".

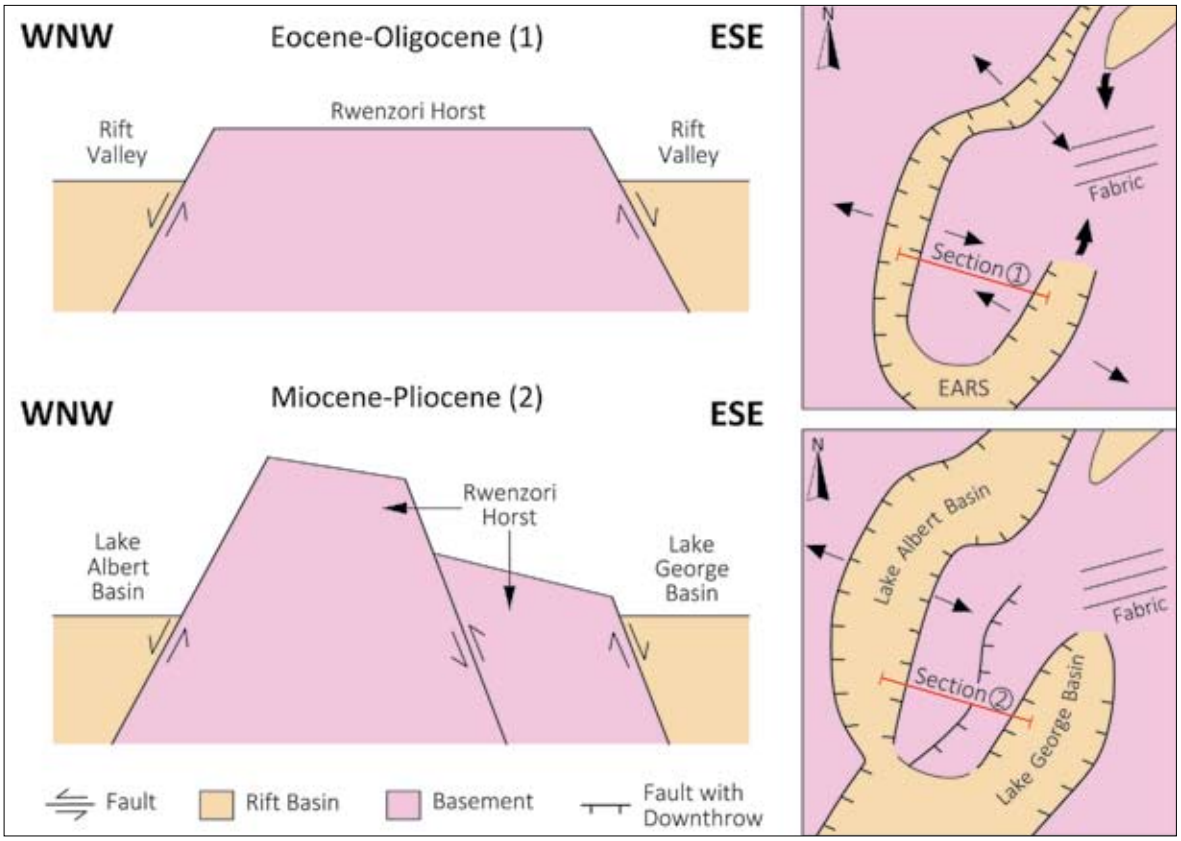
Mount Speke (photo: Albert Backer, 2008, Wikimedia commons).



Geological map of the Rwenzori Mountains and surrounding areas simplified from the Geological Survey of Uganda 1:250,000 Map, Fort Portal (Sheet N.A. 36), published in 1962. The geosites indicate areas of geological interest described in the text.

Belt in Tanzania. This component of the horst was formerly known as the Rwenzori Fold Belt. The dominant lithologies are argillite and quartzite. The argillite may contain significant deposits of copper–cobalt, e.g., at the Kilembe copper mine. In the Rwenzori Mountains, the core part of the fold belt includes a thick unit of amphibolite and it is this component of the Buganda-Toro that is associated with the highest peaks. Parts of the southern and south-western Rwenzori consist of gneiss (granitic gneiss and more mafic components) that, according to recent authors, is part of the Buganda-Toro System. The gneiss is, however, described by the Geological Survey of Uganda as a younger phenomenon (and may be Mesoproterozoic).

The age and duration of the Rwenzori uplift has proved difficult to constrain. The biostratigraphy of lake sediments in the Albertine Rift has been used to infer that the northern section was relatively low-lying during the Miocene and Early Pliocene.[2,9,10] At this time, the rift valley was inundated by the giant palaeo-lake Obweruka. Within the constraints of this hypothesis, uplift of the Rwenzori Horst is constrained to the Pliocene. The uplift subdivided the northern part of



Block diagram showing formation of the Rwenzori Horst with uplift initiated in the Eocene–Oligocene, i.e., several tens of millions of years earlier than has long been suspected (redrawn after Jess et al.[12]).

Lake Obweruka into two basins: the Lake Albert Basin and the Lake Edward Basin. Lake George is a subsidiary feature of Lake Edward (the two lakes were originally joined; they separated in the Late Pleistocene). Most estimates indicate uplift of the Rwenzori Horst occurred in a short time interval, with the peak estimated to have been at 3 Ma.[2,6,7] Some estimates place the duration at 1.2 Ma.[11] However, a recent study, based on application of low-temperature geochronology to rocks within the horst, concludes that uplift occurred over a much longer time interval and was initiated in the Eocene or Oligocene, i.e., approximately 30 Ma earlier than is generally envisaged.[12]

The mechanisms driving uplift of the Rwenzori Horst are also debated. The conventional approach is to relate uplift to the extensional tectonics associated with continental rifting.[2,6,7] An alternative mechanism suggests that a process of rift-induced delamination was the primary driver.[11] The latter process is based on the concept that the lower crust was invaded by upwelling, hot asthenosphere (i.e., a possible driver of the entire EARS). The less dense and colder upper crust was then "delaminated" from the lower crust. The viscosity and strength of the lower crust was reduced by the upwelling asthenosphere. The crustal component of the Rwenzori is dominated by relatively low-density material (granitic gneiss and metasedimentary rocks), which may lend further support to this hypothesis.

The Rwenzori Horst is enclosed by two branches of the rift valley, as noted above, each of which is associated with discrete sedimentary basins. The basins contain mostly Pliocene and younger strata, with sediments derived from erosion of the horst blocks and scarp faces. Parts of the rift valleys are covered by surficial sands and gravels.

*Four crater fields occur in this area, the geological features of which have been reviewed by Woolley[13]. The Bunyaraguru and Katwe-Kikorongo Crater Fields are scenic attractions in the Queen Elizabeth National Park (south of the area shown in the attached map). The **Ndali-Kasenda Crater Field** is located between Fort Portal and the Kibale National Park, encompasses an area of 200 km² in a subsidiary graben, and is a Holocene feature that may remain active. The landscape of lush, conical hills dotted with deep, thickly forested craters is scenic. Thirty of the craters contain small lakes. Some of the smaller craters are blowholes with little ejected material. The **Fort Portal–Kasekere Crater Field** covers an area of 142 km² and includes prominent cones*

of lapilli tuff with heights of up to 150 m. These rocks have been dated at 6000–4000 BP. Each of the crater fields is dominated by tuffs and pyroclastic rocks; lava flows are of restricted occurrence. Pyroclastic rocks may contain basement xenoliths, indicative of their explosive origin. The volcanic rocks are mostly sodium rich (and include leucite), although anomalously potassium-rich lavas have also been identified. The latter have initiated local names such as 'Katungite' and 'ugandite'.[14]

The exhumation of the Rwenzori Horst is ascribed to accelerated rates of erosion during the Pleistocene[2] *(erosion may, however, have commenced in the Oligocene). Identification of multiple cycles of glaciation is supported by mapping of moraines. Some of the larger moraines, which consist of boulders and cobbles together with fine-grained clays and silts, are shown on the geological map. Three glacial epochs are recognised in the Late Pleistocene.*[2] *The earliest activity resulted in ice sheets extending over an area of 500 km*^{2}*. Moraines associated with this activity are notably extensive in some of the deeper valleys. The second glacial epoch resulted in slope glaciers extending to elevations as low as 2000 m. The two earlier glacial epochs have not been dated, but comparison with the moraines on Mount Kenya and Kilimanjaro suggests ages of approximately 400 000 BP and 270 000 BP. A third glacial epoch, known as the Mahoma Stage, is correlated with the Last Glacial Maximum (which occurred at approximately 20 000 BP). This resulted in ice reaching elevations as low as 3000 m.*

Glacial fluctuations of the Holocene, although well known from northern latitudes, are rather poorly constrained in tropical regions.[15] *New data describing the timing and magnitude of Holocene ice retreats in the Rwenzori are, however, consistent with a global pattern for tropical regions (this pattern differs from the northern latitudes).*[16] *The new data are based on the beryllium-10 system, which measures surface-exposure ages. These data indicate that the Rwenzori glaciers experienced rapid retreat in the Early Holocene (11700–8200 BP), with a period of considerable expansion occurring during the Late Holocene (4200 BP–1850s).*

The ice-sculptured landscape currently observed in the Rwenzori is largely due to erosion during the Pleistocene, with additional activity ascribed to the Holocene. A characteristic feature is the radial drainage pattern. Most of the high-latitude lakes are Alpine lakes that formed due to retreating glaciers. The scenic Kitandara lakes located at the base of Mount Baker are well-known examples. They are visible from the Kilembe Trail (the Kitandara Hut occurs

"Trekkers navigate around lower Kitandara Lake on the Kilembe Trail, Rwenzori Mountains, Uganda. Mount Baker rises behind massive Dendrosenecio adnivalis (giant groundsel) trees". © Jake Norton/ MountainWorld Productions. All Rights Reserved.

at an altitude of 4023 m), probably the most popular route to the central peaks.

Historical reports indicate that the icefields of the Rwenzori shrank considerably in the latter part of the 19th century, as well as during the 20th century. During the waning stages of the Little Ice Age (which ended at approximately 1850), the icefields may have covered an area of approximately 10 km², with glaciers occurring to elevations as low as 4300 m. Studies based on satellite imagery (including Landsat Thematic Mapper) showed that by 2005, the Rwenzori icefields were restricted to the three highest massifs and covered an area of only 1.5 km².[17,18] The Landsat imagery for this period may, however, have included significant areas of snow, and a new estimate suggests that the icefields decreased in size from 2.55 km² in 1987 to 1.31 km² in 2006.[19]

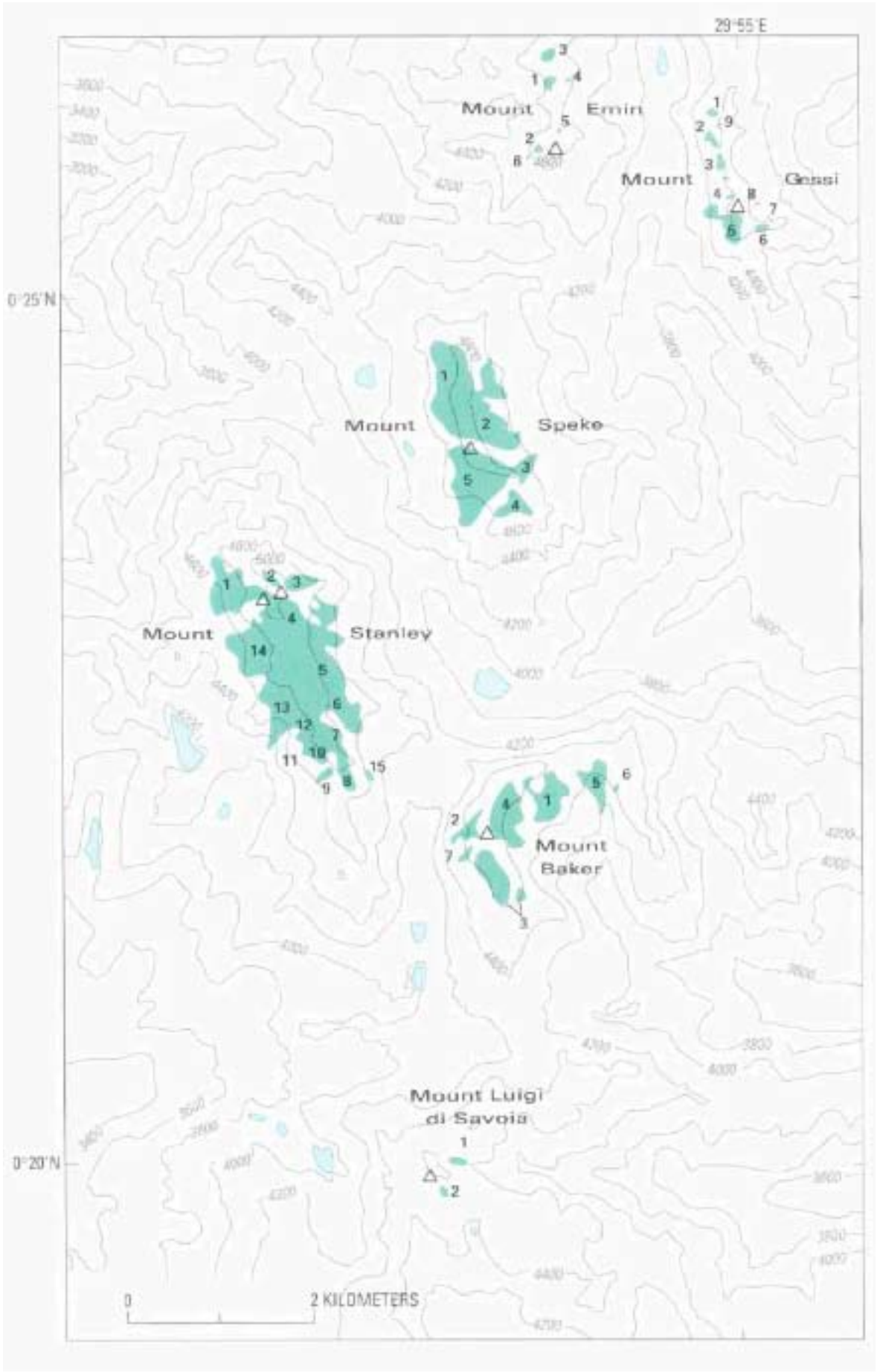
The Rwenzori Mountains are prone to devasting landslides. Some 48 major landslide and related flash flood events have occurred during historical times.[20] This is not unexpected of mountains with steep slopes and a wet climate; rainfall may exceed 300 mm each month. The active nature of faults may exacerbate the situation in the Rwenzori. Some landslides have been related to earthquakes, such as the 1994 event in the Kasese District.

*The **Rwenzori Mountains National Park** was gazetted in 1991 and afforded world-heritage status in 1994. The park covers an area of 996 km² and includes approximately three-quarters of the mountain range (the eastern slopes and central peaks). The forested valleys that radiate outward from the six massifs report a humid, almost tropical climate, but the mountain slopes are extremely cold, with average temperatures below freezing. The Rwenzori Mountains host several species or subspecies of fauna named from the region, including the Rwenzori colobus (a subspecies of the Black and White Colobus monkey), the Rwenzori turaco (Ruwenzorornis johnstoni) and the Rwenzori double-collared sunbird (Cinnyris stuhlmanni).*

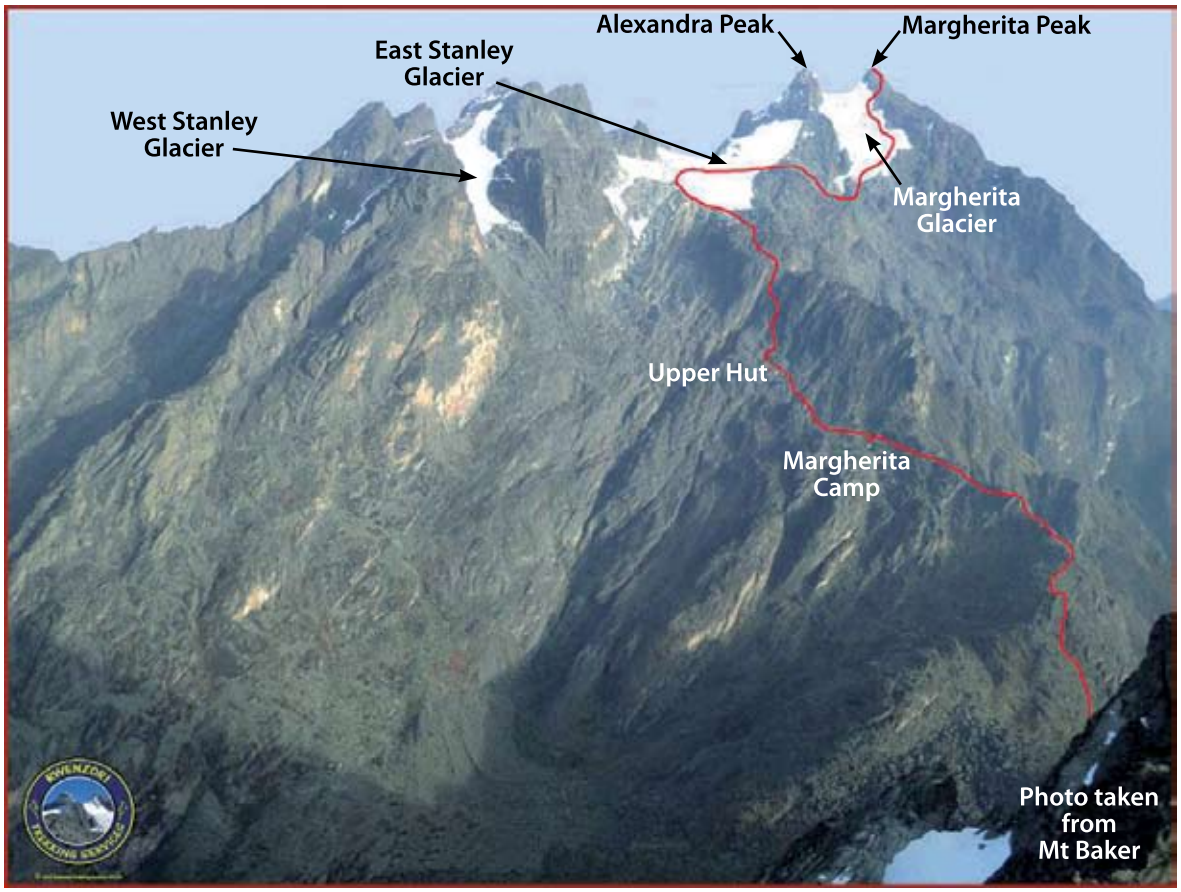
The Rwenzori Mountains are well known for distinct botanical zones dictated by elevation. Five zones are recognised (they each overlap). The Afromontane forest, a mostly dense, evergreen forest with patches of tropical forest, occurs at elevations of 2500–2800 m. The Afromontane forest is succeeded by bamboo forest at elevations of 2500–3300 m, which in turn gives way to a heather zone at elevations of 3000–4000 m. The Afro-alpine moorland occurs at elevations above 4000 m. Giant species of lobelia and groundsel, some of which are endemic, are hallmarks of the upper heathlands and moorlands in the Rwenzori. Examples include the Lobelia wollanstonii (which can grow to heights of 10 m) and giant groundsels Senecio admiralis and Dendrosenecio adnivalis (with heights of up to 6 m). The slopes higher than 4400 m constitute Alpine desert. The shrinkage of the icefields in recent years has impacted vegetation on the high peaks and moorland species may occur at higher altitudes than previously reported. The unusual nature of the Rwenzori flora may be ascribed to a theory that the African mountains were almost void of vegetation until land contact was established between the African and Eurasian Plates in the Early Miocene (at approximately 18 Ma). This event triggered a mass migration of cool-climate-tolerant plant genera, resulting in a colonisation of the African high-altitude areas.[1] This process does not, however, account for the presence of species endemic to Africa. Similarities with flora in the Cape mountains presents an additional problem.

Treks in the Rwenzori Mountains National Park start from each of the three main entrance gates, Kilembe (southern), Nyakalenjija (central) and Kazingo (northern). The best times for trekking are the relatively dry months of January and June–July. The longer treks are strenuous. Treks from the Kilembe Gate include a 9-day trail that summits Mount Stanley and a 6-day trail to summit Mount Luigi da Savoia. The Central Circuit is a 7-day circular trek that commences from the Nyakalenjija Gate. This trail may include Mounts Baker and Stanley. A 2-day hike to the scenic Lake Mahoma can also be undertaken here. The Kazingo Trail in the northern Rwenzori is a one-day traverse of a high ridge with views of the most northerly peak of Karangora (3014 m), as well as of the Semliki Valley.

*The **Semliki National Park** was upgraded in 1993 from the Semliki Forest Reserve, the latter having been created in 1932. This is one of Uganda's smallest protected areas, covering an area of 220 km². The park is located within a low-lying segment of the Lake Albert branch of the rift, which has an elevation of 670–760 m. The 60 km-long road from Fort Portal, which descends over 700 m into the rift*



Map of the Rwenzori showing peaks (triangles), glacial lakes (blue), and glaciers (green) of the Ruwenzori based on data from 1985. Selected names of glaciers on Mount Stanley: 1. Alexandra, 2. Albert, 3. Northeast Margherita, 4. Margherita. (Source: Young and Hastenrath[4]).



Climbing routes on the face of Mount Stanley (view from Mount Baker looking northwest). (Photo: Rwenzori Trekking Services, Uganda).

valley, has scenic views. The relatively low elevation has resulted in the Semliki Valley having an equatorial climate and the park is covered by dense rainforest of Central African heritage. The lowland rainforest is considered to represent the eastern limit of the Ituri Forest that covers large parts of eastern DRC. The Ituri Forest is one of the few forests to have survived the Main Ice Age (which resulted in a drier climate in the tropical latitudes). The unusually rich biodiversity includes fauna and flora of both East and Central African heritage. There are 53 mammals, which include eleven species of primates. An interesting variant of the Central African species is the pygmy hippopotamus (Choeropsis liberiensis). Of the more than 440 species of birds recorded in the park, 35 are found nowhere else in East Africa. The biodiversity is also ascribed to the relative age of the forest cover, which may predate the Last Glacial Maximum. The forest has an estimated age of 25000 BP but is probably considerably older.

A highlight of a visit to the Semliki National Park is the Sempaya hot springs and geyser. Hot geothermal waters bubble up from active faults associated with the rifting. The ***Nyansimbi Geyser*** *includes a pool where boiling water and steam are ejected several metres into the air. The geyser is located next to the Visitors' Centre at Sempaya and is surrounded by small springs with boiling water. The 12 m-wide steaming* ***Bintente Pool****, which is situated in a forest clearing, is accessed by a 1-hour walk on a forest trail with a boardwalk. The 14 km-long Kirumia Trail accesses parts of the forest and the Semliki River. This trail has opportunities to observe many species of fauna and flora.*

The Semliki Valley has yielded significant archaeological finds (mostly in the DRC). They include evidence of hominins (Pliocene and Pleistocene) and Homo sapiens (Pleistocene). Bones dated at approximately 90 000 BP are from Homo sapiens that reveal a complex subsidence specialisation.[21] *This is ascribed to the Early Palaeolithic, which includes specialisations unique to Africa. The date quoted above is supported by faunal fossils in the Lusso Formation, sedimentary rocks deposited during the Late Pleistocene.*[22]

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Sempaya hot springs, Semliki NP (https://images.app.goo.gl/7CjwRKDYJHZgaUcbA).

The support of professional photographer and mountaineer, Jake Norton (MountainWorld Productions), for use of two photographs that are under licence, is greatly appreciated. Captions to the photographs were provided by Jake. Thanks also to Rwenzori Trekkers, Uganda, for providing photographs. Satellite images were processed by Philip Eales and the geological map and block diagram, as well as processing of the Google Earth image, were by Lyn Whitfield.

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The Margherita Peak (right) on Mount Stanley, Africa's third highest mountain, is separated from Alexandra Peak by relicts of the Margherita Glacier (photo: Rwenzori Trekking Services, Uganda).

zoom events 2021

2021 GSSA Zoom Events

VP Meetings - Noleen Pauls: noleen@fastmail.fm

DATE	EVENT
9 February - 2 March (4 x ½ days) + self-study	Drilling Methods and Techniques in Resource Exploration
26 February	REI colloquium
15 March	CPD Workshop
24 March	GSSA | WIMSA - Fostering a safer workplace for Geoscientists
16 April	Clean & Green Day
11 May - 15 June (6 x ½ day)	Foundations for a Geological Career
17 - 19 May (3 x ½ day)	Economic Analysis in Minerals
25 June	Precious Metals Day
14 July	Geotechnical Workshop
25 July	Teaser to Geocongress 2022
20 - 22 August	Advanced Structural Geology/Field Trip
27 August	ESG Workshop
7 - 28 September (4 x ½ days) + self-study	Drilling Methods and Techniques in Resource Exploration
16-17 September	Project Management for Geologists
8 October	3-D Geological modelling
19 October	CPD Workshop
27 October	Coding/Programming 101
11 November	Technology Day
12 November	African Exploration Showcase

CLEAN AND GREEN DAY

16 APRIL 2021 | 08.30AM - 5PM

8 GSSA
1 SACNASP
CPD
POINTS

ABOUT THE COURSE

The world is attempting to shift towards more sustainable sources of energy to power our ever-growing world of technology. At the same time, the mining industry is constantly under pressure to reduce its impact on the environment, along with any further damage in the years that follow the closure of a project.

This one-day online event aims to give you insights into the cleaner, greener renewable energy sources available, as well as the innovative technologies being implemented by well-established mines to reduce environmental impact. The short course is aimed at geologists, environmentalists, engineers and researchers, as well as anyone with a background knowledge and understanding on the fundamentals of renewable energy and cleaner mining.

Registration Fee

Member - R1000 | Non Member - R1500 | Student/Retired - R500

Click here to REGISTER

info@gssa.org.za

GSSA & WIMSA - FOSTERING A SAFER WORKPLACE FOR GEOSCIENTISTS

24 MARCH 2021 | 08.30AM - 5PM

8 GSSA
1 SACNASP
CPD
POINTS

wimsa
WOMEN IN MINING SA

ABOUT THE COURSE

An up-to-date look at harassment in the modern geoscience - workplace and how best to prevent incidents while providing adequate support for those who come forward. A review of frameworks for accountability and why it matters will be provided. The talk will also look at the unique challenges facing geoscientists today in industry as well as in academia.

"I think a webinar like this would be of special importance because field geologists regularly find themselves in isolated areas with problematic, creepy or even threatening male co-workers or supervisors. I do realize men can also be harassed, another item that should be addressed. In the past two months I've had two friends quit their positions because of sexual harassment and the appalling, ineffectual handling of their reports. This included the leaking of confidential emails which resulted in intensified harassment with added bullying. I think a refresher for employers on how to handle such incidents is necessary." - Anonymous

Free Registration

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rates card 2021

excl VAT & commission

1. ADVERTISING RATES (Excl. 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.

Black & White

Size	Casual 1-3 insertions	4+ Insertions
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Half Page	R 7 490.00	R 6 735.00
Quarter Page	R 4 960.00	R 4 255.00

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5. DEADLINES FOR COPY AND ADVERTISING MATERIAL

March issue:	15 February 2021
June issue:	15 May 2021
September issue:	14 August 2021
December issue:	15 November 2021

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. **Circulation exceeds 3150 recipients plus website visitors, and reaches decision makers in the geoscience community including industry, academia, and government.**

8. ADVERTISING BOOKINGS AND SUBMISSION

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