GSSA
Geological Society of South Africa

geobulletin

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news

4th Industrial revolution in the minerals industry
Anniversary: Arthur William Rogers
GSSA Geoconservation
Zinc-Lead mining, Northern Italy


GSSA
Geological Society of South Africa

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Front cover photo:

"View of the Wolkberg, Limpopo" by Cilliers Marais.
Second place winner in the Geoheritage Photo Competition at the Geoheritage Conference 2022.

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guest editorial

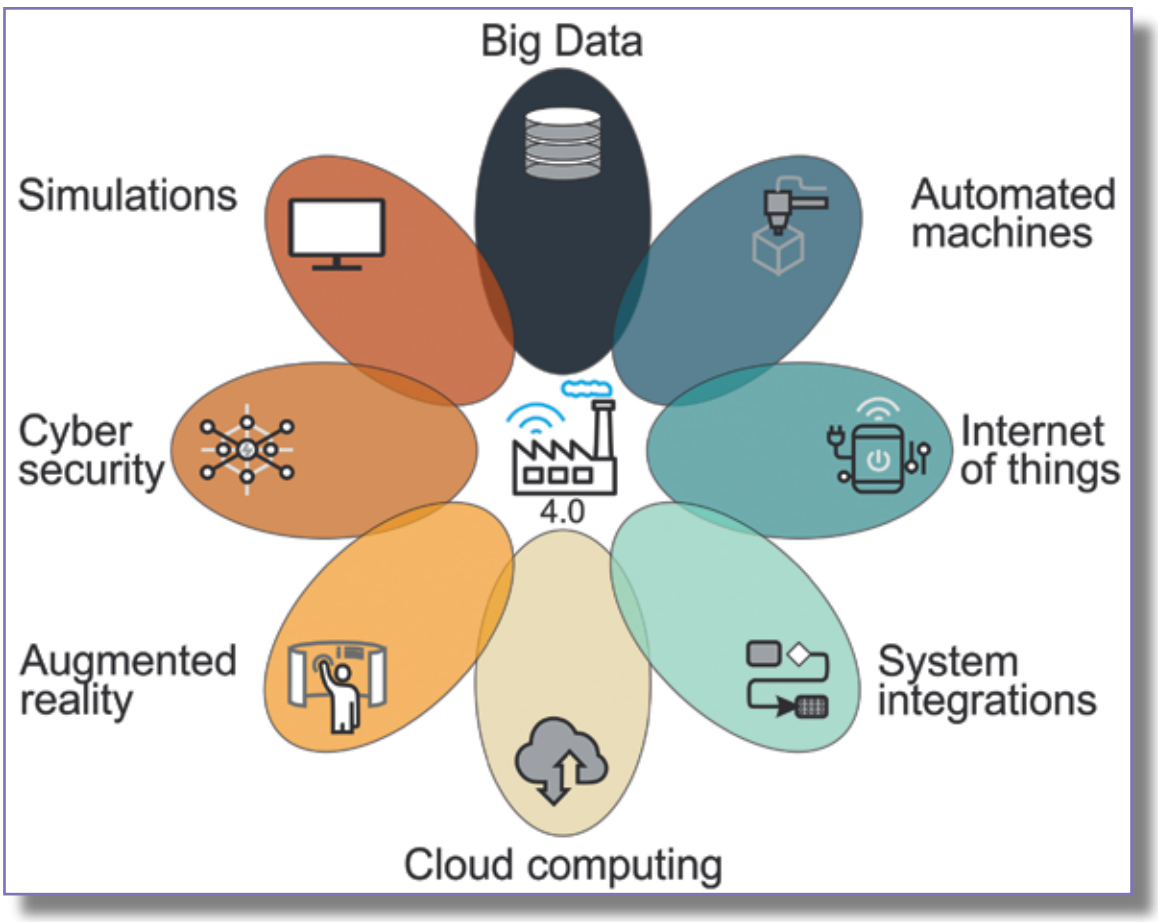
Glen Nwaila

People-centric, globally competitive, and sustainable 4th industrial revolution in the minerals industry

The quest to improve the quality of life, digital transformation and leverage big data analytics has shaped the landscape of the 21st century mining model. Without a doubt, we are living in a once-in-a-century transition that is fast-tracked by issues of sustainability, climate change, the just energy transition, the emergence of new technology, evolving operating environments and multifaceted social challenges. Every transition comes with its opportunities and challenges. Through four main components, known as **"DARQ"**, the **fourth industrial revolution (4IR)** or **Industry 4.0** provides intelligent solutions to enable just, sustainable, and competitive transitions in the minerals sector:

(a) Distributed ledgers: use independent computers (referred to as nodes) to record, share and synchronise transactions in their respective electronic ledgers (instead of keeping data centralised as in a traditional ledger). In the minerals industry, Blockchain is one type of promising distributed ledger that organises data into blocks chained together in an append-only mode. Supply-chain tracking and traceability of raw materials and saleable downstream products in the minerals and extractive industries may be fundamentally changed by distributed ledger technology (DLT).

(b) Artificial intelligence: uses a variety of computational models that mimic human intelligence and is a core component of modern data-driven approaches. In the minerals industry, artificial intelligence is

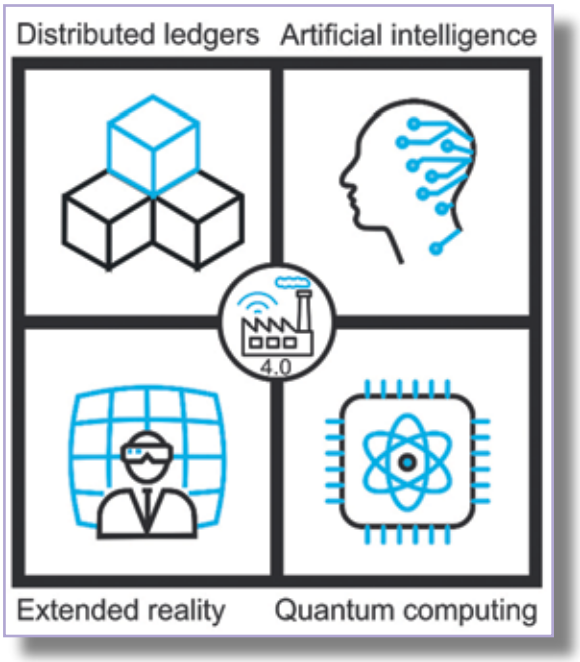


The 21st century 4th industrial revolution technologies.

experiencing a surge of applications. It could theoretically provide a pathway to better management, further automation, efficiency enhancements and improved human health and safety. In addition, artificial intelligence can provide additional operational and scientific insights that are impossible or unfeasible with existing methods.

(c) Extended **R**eality is expanding human perception and interaction with physical and abstract realities using virtual and augmented reality methods. Extended reality provides the minerals industry with a large and very engaging toolkit of interaction methods that could facilitate operations and management, education, training, and talent development. The use of extended reality can overcome the abstractness and repetitiveness of traditional interaction methods and potentially improve information uptake and retention, motivation, and outcome.

(d) **Q**uantum Computing: uses quantum phenomena to perform computations that are otherwise impossible with traditional computation systems. In the minerals industry, quantum computing can, for example, solve more complex optimisation problems and generate more complex and creative chemical reagents than is possible with classical computing approaches.



Application of DARQ technologies in the minerals and extractive sector.

Given that innovation and digital transformation are costly and often risky to adopt, some of the key questions that continue to be asked by various stakeholders of the society and the minerals industry revolve around:

(a) the role of the minerals and extractive sector in driving innovation and sustainability in a competitive mining environment,

(b) the type of technology and infrastructure to facilitate digitalisation and risk compartmentalisation,

(c) the framework for ESG that is suitable to address local issues,

(d) the need to decarbonise modern economies, and

(e) the nature of skills required during the transition period and after the implementation of modern technology.

To address these recurring questions, cross-disciplinary (i.e., the collaboration between different disciplines such as engineering sciences and humanities) and trans-domain (i.e., collaboration between universities, government agencies, civil society, mining industry and professional organisations) research and innovation are required. It is necessary to conduct a comprehensive analysis of industry gaps. This will enable us to answer the first question about **the role of the minerals and extractive sector in driving innovation and sustainability**.

In fact, digitalisation and big data analytics in the minerals industry are not new concepts by any means, since each mining operation already collects a substantial amount of multivariate and multi-scale data at various stages of the mining and beneficiation processes. For example, data collected from development tunnels, mining sites (e.g., benches and stopes), ventilation and

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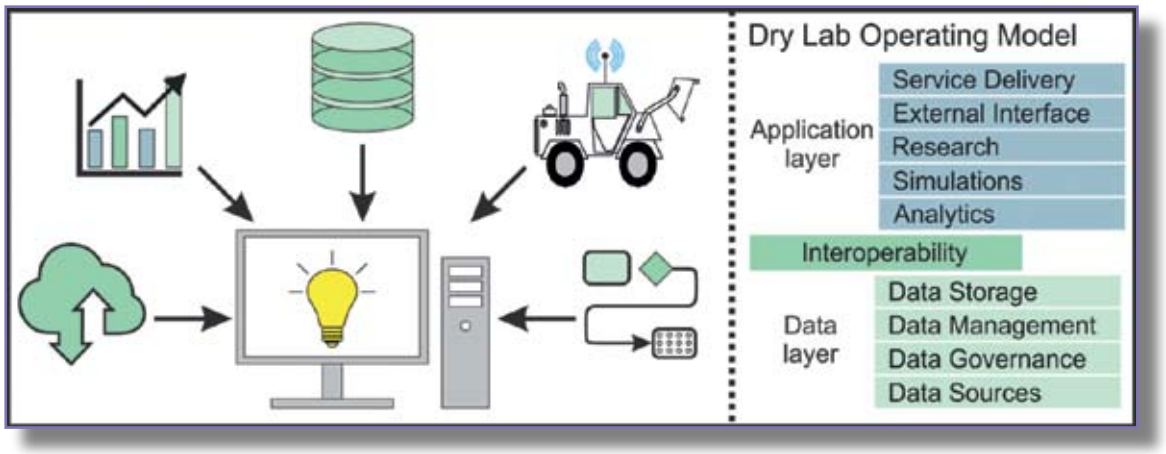
environmental monitoring systems, and sensors/scales in the metallurgical plant. Currently, most of these data are stored in silos and used only for monitoring and forecasting production. Quantifying the gaps and changes required to adapt and implement an operating model that meets the 21st century industry configuration by mapping the existing personnel skillset, infrastructure, and technology is essential. Census data can also be used for constructing technological and people-readiness maps in the adoption and maturity stages of digitalisation. In order to foster realistic and durable outcomes, a cost-benefit analysis would be necessary before implementing any new technology. After gap analysis, it may be possible to develop an agile roam map that channels proof-of-concept and proof-of-value work to university research institutes such as the Wits Mining Institute. The next step should be to co-create pilot technologies with tech firms or professional organisations such as the Council for Scientific and Industrial Research (CSIR) or Mandela Mining Precinct in South Africa, or the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia.

Once the technology has been tested in the two previous stages, it can be implemented by the minerals and extractive industries in an inclusive manner that is people-centric. An inclusive co-creation approach has been proven effective in various technological breakthroughs. In the first and second industrial revolutions, Benjamin Silliman Jr., a Yale University chemist, devised the process of fractional distillation, enabling kerosene's economic production. This revolutionised the petrochemical and energy industries. Quantitative mineralogy has been another cross-disciplinary and cross-domain breakthrough in the past few decades, leading to the creation of new disciplines (such as process mineralogy and geometallurgy) and new technologies, such as the quantitative evaluation of minerals by scanning electron microscopy (QEMSCAN). This was developed by university researchers and the CSIRO and later adopted by the minerals and extractive industries. These two examples illustrate how co-creation can facilitate 21st century mining model adoption.

Aside from data issues, there are concerns about inadequate digital infrastructure, data flows and management, skills misalignment between the current mineworkers and what the 21st Century mining model requires. The **type of technology and infrastructure to facilitate digitalisation and risk compartmentalisation** can be addressed via the development and implementation of dry laboratories ("dry labs"). A dry lab is a counterpart to traditional wet laboratories and focuses on using data and digital technologies. A dry lab is intended to perform innovation and experimentation type of research and development, while centralising resources and management to enable: (a) risk compartmentalisation, (b) reward maximisation, (c) staff recruitment and retention, and (d) prove an interface between academics and the minerals industry. This, in turn, will help the minerals and extractive sector isolate risky innovation and experimentation from existing operations while pursuing innovation and experimentation. A key advantage of dry labs is that they provide a purposeful space and infrastructure and leverage data, algorithms, and computation in a centralised manner (e.g., a hub). Dry labs can also quickly accrue a sufficiently high quantity, quality, and variety of data to attract modern talents (e.g., data scientists), which may be impossible in traditional academies or businesses (due to lack of infrastructure and sustainable data flows). Lastly, dry labs can help mining companies maximise the value of data to the minerals industry by adopting modern data science and analytics approaches to retrieving, processing, and interpreting data.

ESG framework with South African characteristics

South Africa is well experienced in strategically addressing most of the 21st Century minerals industry challenges, given its long mining legacy and unique environmental, social, and governance (ESG) challenges. ESG impacts from legacy South African operations are readily appreciated by both



A schematic representation of a dry lab configuration.

academics and the broader community, such as the effects of mine tailings. The unique characteristics of South Africa, including its history, people, infrastructure, education, and societal challenges, are not mirrored as a whole in any other country. As the middle class in South Africa is relatively small and abject poverty is still rampant, the establishment, adoption, and implementation of any ESG framework should be entirely based on a South African context, which is to say, South Africa requires an ESG framework with South African characteristics. The Wits Mining Institute is working on starting a new research centre on the **"Future Mines and Minerals Initiative"**, and ESG issues are core to this proposed initiative.

The need to decarbonise modern economies

Although industrialisation has brought many opportunities, it has also produced significant greenhouse gas emissions. During the industrial age, humans significantly increased the amount of greenhouse gases in the atmosphere by burning fossil fuels such as coal, natural gas, and oil. This enhanced the planet's natural greenhouse effect and contributed to higher temperatures during the subsequent decades. All livelihoods and our planet are at risk from these emissions. If history has taught us anything, most creative solutions tend to be born and developed when challenges are present. The minerals and extractive industries have faced the problem of how to recover valuable minerals from ores at some point in history. After a thorough understanding of ore-forming processes, it was soon discovered that these processes could be reversed to recover minerals.

As a result of this knowledge, efficient separation, and hydrometallurgical methods such as comminution, flotation and leaching were discovered to reverse the natural processes of ore-forming. In applying this analogy to our current challenge of decarbonising our industries, we can discretise the problem into several blocks, beginning with (a) geological properties of rocks and minerals (i.e., both in-situ and on mineral processing products such as tailings), followed by (b) process engineering for capturing and transporting greenhouse gases (CO_2), as well as (c) designing methods for storing them. These three blocks have been consolidated into a "negative emissions technologies" (NETs) initiative, with most scientists proposing implementation at mine or tailing sites. NETs are part of a broader global response to limit temperature increases to below 2 °C over the next few decades, according to the Intergovernmental Panel on Climate Change (IPCC).

The advancing concept of "enhanced weathering of rocks" holds promise as a NET method of removing CO_2. Based on this method, atmospheric CO_2 is converted into carbonate minerals or ions through an accelerated chemical breakdown of rocks. The CarbFix Project (https://www.carbfix.com/) has demonstrated that basalt, a common fast-weathering volcanic rock at the Earth's surface, is a highly appropriate rock type for direct CO_2 injection

and deployment on croplands through the spreading of crushed basaltic rocks. This demonstration is relevant primarily in South Africa's context, given the abundance of mafic and ultramafic rocks and their tailing products at mine sites. Early work done by various South African academics, such as Emeritus Professor David Reid and Professor Megan Becker, together with their former post-graduate researchers (e.g, Jacques Vögeli, Maxwell Amponsah-Dacosta and Nicole Anne Meyer) at the University of Cape Town has already demonstrated that millions of tonnes of tailings produced each year in the Bushveld Igneous Complex (South Africa) may represent a climate change solution if adequately studied for their potential CO_2 storage. Notwithstanding the field and strategic efforts of governments that are managed by geological surveys such as the Council for Geoscience (CGS) in South Africa targeting legacy underground mines and other geological sites, more geoscientific and engineering-based solutions and test work in a controlled environment remains to be undertaken. The university setting provides a suitable space to test the amenability of particular rocks and minerals for CO_2 uptake, and design appropriate capture and transportation media. If proven efficient in various laboratories, these efforts will ensure that the minerals and extractive industry contributes toward the NET initiative without disrupting the current energy supply, until an environmentally benign energy mix is progressively phased in.

A philosophical and technical approach is required to address **the nature of skills needed** during the transition period and after the implementation of modern technology. Central to this transition is the role of academies, whose task involves developing relevant technical skills, including critical thinking skills, to enable a 21st century mining model and to prepare graduates for the future of work. The impact of Covid-19 and 4IR on universities is significant, with one measure of success being the employability and entrepreneurial skills of the graduates. Academies are also well positioned to project and profile anticipated changes that will happen in the future through research and development, e.g., exploring, developing, and testing new and emerging technologies. In my opinion, if there is a perfect moment for anything, this is a one-of-a-kind opportunity where the **university curriculum should be transformed** from traditional approaches to one that trains students to adopt a system-thinking approach that integrates discipline-specific knowledge with technical skills, coding, ethics, and global citizenship. Professor Fred Cawood, the former director of the Wits Mining Institute also emphasises this need for academic curricula transformation where learning content and teaching delivery for society and industry relevance must blend teaching and learning content and methods with teamwork and leadership principles.

Conclusion

The digital age continues to bring many opportunities for the minerals and extractive sector to address its chronic and recent challenges associated with business sustainability and ESG practices. By bridging the gap between purely academic research and development and business realities within the industry, and working with a multidisciplinary team, we can strive together toward a people-centric, globally competitive, and sustainable future.

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UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

executive manager's corner

Craig Smith

Welcome to the third issue of *Geobulletin* this year. At this point, the COVID pandemic seems to be mostly behind us, with travel and work-related events returning to some degree of normalcy. However, it seems clear that life will never completely return to pre-pandemic norms. Many of our members are busier than ever, but working from home. This is the case for the GSSA staff, though the office in the Mandela Mining Precinct is still manned on a part-time basis. Organisations running events are beginning to return to face-to-face meetings, but are also finding that many delegates prefer attending online. The savings in time and money for online events is significant for both event hosts and delegates. During 2022, the GSSA or its branches and divisions have staged a few full-contact events, and those will continue to increase in number. But online events are here to stay.

Two important contact events coming up are the Fellows Dinner in Johannesburg on 11 November, and Geocongress in Stellenbosch on 11–13 January next year. Save those dates! For more about Geocongress, see https://allevents.eventsair.com/geocongress/. Registration for in-person attendance as well as abstract submission opened in August, and the GSSA has embarked on a sponsorship drive. This is a great opportunity to increase company visibility in the general earth science community. Contact craig.smith@gssa.org.za if you are interested in becoming a Geocongress sponsor.

Two other upcoming contact events that may be of interest to GSSA members are the SASQUA conference at St Lucia in KZN 25–30 September (https://sasqua.co.za/sasqua-2022/), and the SAGA meeting at Sun City 28 November to 1 December (https://sagaconference.co.za/).

The GSSA is commencing the budgeting process for 2023, but there are still a significant number of members who have not paid their 2022 annual fees, despite having been sent invoices several times. Please pay your annual fees! The Society needs the income from subscriptions to cover fixed costs, as well as allowing more events to be staged at relatively low cost. Members in good standing enjoy discounts on events, and in some cases free entry to events. We are continually trying to increase and improve member benefits, but this requires that members pay their fees. As we move into an era of hybrid meetings, financial planning for any given event becomes less certain, and fees collection will become increasingly important.

The 2023 events calendar is now being developed, thanks to a very active Meetings Committee. A proposed events schedule is published in this issue, and if anyone has further suggestions, we need to hear from you.

GSSA Branch and Division activity has been a focus area, and for the first time the Management Committee has created a Vice-President post and appointed Masibulele (Masi) Zintwana to assist and coordinate Branch and Division activities as needed. In a post-pandemic world, we believe the Branches and Divisions will become increasingly important in the development of professional networks—of particular importance for young professionals and career building. Please support your local Branch or Division.

Craig Smith

president's column

Tania Marshall

September is supposed to herald the coming of Spring to the southern hemisphere, although we all know that there will be one or two cold fronts before winter is finally over—it has even snowed in springtime in Johannesburg (remember the 10 cm of snow in 1981). Spring is also supposed to announce new life, new beginnings and transformations.

Some of the new beginnings and transformations that we would like to see in Geoscience include an explosion of exploration activities in South Africa. The DMRE has set an annual target of attracting USD900M in mining exploration expenditure by 2025—the equivalent of some 5% of the global exploration spend (www.mining.com). In order to achieve this, the DMRE proposes to remove administrative bottlenecks, improve resource-mapping through its association with the Council for Geoscience (and the updated Geoscience Regulations), promote the establishment of a junior exploration fund, and diversify its reliance away from gold/platinum and even coal, to minerals necessary to progress the green revolution. These proposals are like the first green shoots of spring—promises of an exciting harvest. But, just as late cold-fronts and unexpected snow can smother or even kill off the tender sprigs, so can a lack of detailed implementation plans, well-meaning but ill-conceived legislation and apparent limited political will stunt the strategy to promote exploration. It remains to be seen whether we welcome an explosion of colour or the deathly silence of an extended winter.

Despite the forecast, live like it's Spring (Lilly Pulitzer). In an attempt to pre-empt exploration, the GSSA is planning a series of online and hybrid learning events for the rest of 2022 and into 2023 that are planned to assist explorationists. In addition to our standard, popular drilling, mapping, 3-D modelling, and data analytics offerings in conjunction with our annual partners, we will also be offering a new structural fieldtrip, a dedicated commodity day focussing on base metals, a sampling and data-management event and more exploration-focussed events. Please look out for our "Save the Date" and registration fliers on the website (Upcoming Events – GSSA). This year's "African Exploration Showcase" will highlight exploration and mining ventures as well as programmes managed by a number of African geological societies. While waiting for November, please also check out the talks offered by our partners and sister societies (Partner Talks – GSSA).

You may remember that last year in mid-August, the GSSA hosted an ESG Inquisition to try and understand some of the complexities around ESG reporting in Public Documents. The takeaways from this event recommended that a Working Group be constituted with representatives from the SAMREC, SAMVAL and SAMOG Committees, from large companies, junior companies and consultants. The mandate of such a Working Group would be to assist the SAMESG Committee to update the SAMESG guidelines and ensure integration and alignment with the SAMCODES in a manner that is both practicable and useful. Based on these recommendations, this ESG Working Group has been hard at work trying to fulfil this mandate. A feedback session has been organised for 8 November and this will be of particular interest to all Competent Persons/Valuators. Please bookmark the date and watch the website for further details.

Tania Marshall

GSSA
Geological Society of South Africa

letter to the editor

Magnet Heights—then and now

Recently, as I was searching on the Internet for historical information about the Driekop platinum pipe, I came across Dr Roger Scoon's "The Geotraveller" heritage article about the Eastern Limb of the Bushveld Igneous Complex (*Geobulletin*, June 2022). The photo on page 43, depicting the outcrop of the Main Magnetite Layer (MML) in a stream bed at Magnet Heights (Geosite G21), caught my eye as it reminded me of a similar, much earlier, photo of the same outcrop that I had seen before.

After a brief search in Memoir 28, titled *The Bushveld Igneous Complex of the Central Transvaal*, by Dr A.L. Hall, I found the photo I had recalled, as Plate XXX in this publication. Dr Hall, leaning against the outcrop, credited the image (published in Memoir 28) to L.T. Nel. I recognised this particular photo as being part of a batch of about 65 old unnamed glass negatives stored in the archives of the Council for Geoscience that I had been tasked to photograph and convert into digital images about seven years ago.

Upon closer inspection of the digital image, it became apparent that the old photo in Memoir 28 had been taken from almost the same vantage point as that from which the newer colour image had been captured, albeit from a slightly higher elevation. As Memoir 28 had been published in 1932, this meant that the glass negative must be at least 90 years old. Although slightly damaged, the negative was still in a reasonably good condition.

From the more recent image, it is apparent that, since the older photo had been taken, plants and soil have been cleared from behind and to the left of the outcrop. Also notable is that some of the loose rocks are no longer there and the uppermost rock edge of the magnetitite outcrop near the centre of

Google image showing the location of the MML outcrop (approx. 24°48'37.81"S, 29°58'26.73"E).

Recent photo of the MML, published in the Geobulletin of June 2022, showing delegates of the 2016 IGC visiting the Magnet Heights outcrop (photo: R. Scoon).

the coloured photo appears slightly more rounded than in the older photo. Although natural processes may account for this change, it is more likely that years of sampling by visitors to the outcrop is a major contributing factor.

The rock face against which Dr A.L. Hall's hammer is leaning and the flat face of the rock on the bench above the hammer are clearly discernible in both photos. Near the centre of the later photo, the man wearing a blue T-shirt and grey trousers, leaning over on the middle tier of the outcrop, appears to be standing on the same rock on which Dr A.L. Hall is seen to be resting his feet in the older photo.

So, if you are an enthusiastic follower of Dr A.L. Hall and his work and would like to experience how it is to follow in this great geologist's footsteps, go and visit the site, lean against the outcrop and strike the same pose for a great photo!

Rehan Opperman
Council for Geoscience
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Digital image of the original glass negative from the archives of the Council for Geoscience. This image was published as Plate XXX in Memoir 28 (1932) and had been taken from approximately the same vantage point as the more recent photo.

review of the year

GSSA Professional Affairs—Review of the year ending June 2022

The Professional Affairs Committee's (PAC) role is to advance, promote and protect the professional status of GSSA members, actively represent the members on the appropriate national and international statutory and professional bodies, and to ensure that appropriate educational, registration, professional indemnity insurance and reciprocity needs are investigated and addressed.

The following is a summary from the July 2022 GSSA Annual Report, highlighting what kept the PAC busy during the last year.

Representation on other bodies

1. SACNASP

The GSSA is represented on the SACNASP Council by Neale Baartjes and George Henry.

There are 3,000 active Earth and Geological Science members, representing a fifth of all SACNASP members.

In its 2020–2025 Strategic Plan, SACNASP has committed to, and remains focused on the following five steps:

- To proactively advise government and relevant stakeholders on the contributions and role of the natural scientific professions in South Africa;
- To enforce high professional and ethical standards for the natural scientific workforce;
- To promote the natural science professions and science engagement in South Africa;
- To promote the professional development and transformation of the natural science sector in South Africa; and
- To foster a culture of good corporate governance.

The GSSA has a process in place to support each of the above commitments.

2. SAMCODES Standards Committee (SSC)

The GSSA is represented on the SSC by Tania Marshall (Past Chairperson for 2020/2021), Sifiso Siwela (Deputy Chairperson) and Nicole Wansbury (GSSA representative).

The highlight of the SAMREC Committee (*Ken Lomberg, Chair)* has been the rollout and application of the SAMCODES App on Android and Apple platforms, which has led to many individuals accessing the SAMCODES via their phones.

The SAMVAL Committee (*Andrew van Zyl, Chair*) compiled "Guidance Notes" for the website and has been involved in, among other things, reviews of "Independence", an issue raised by the JSE, which is considering requiring independent sign-off for new listings (and possibly material change documents).

The SAMOG Committee (*Peter Dekker, Chair*) has primarily been involved in the update of the SAMOG Code, based on issues developing from a review of the PRMS/COGEH reporting systems.

The SAMESG Guideline Committee (*Teresa Steele-Schober, Chair*) has focused on sensitisation of geoscientists and engineers to the importance of

ESG issues in the minerals industry and an update of the SAMESG Guidelines.

The SAMCODES ESG Working Group (*Andy McDonald, Chair*) comprises representatives from the other code committees and various industry groups. During its first year of being, it has been focused on contextualising the expectations of business, mining companies, investors and regulatory bodies and distilling key conclusions and learnings from GSSA ESG Inquisition.

3. Global Geoscience Professionalism Group

The Global Geoscience Professionalism Group (GGPG) provides an international forum for discussion on matters of common interest among professional geoscience organisations.

It is made up of representatives from the GSSA, Geoscientists Canada, International Raw Materials Observatory (INTRAW), American Institute of Professional Geologists (AIPG), European Federation of Geologists (EFG), SF4 Expert Group for Raw Materials and Australian Institute of Geoscientists (AIG).

Continuing Professional Development

The GSSA Continuing Professional Development (CPD) programme has been in existence since 2014. The GSSA also has a functioning MOU that recognises SACNASP CPD points and vice versa, so that GSSA members can log their points on the GSSA website.

During 2021–2022, the GSSA ran one online CPD training course. Recordings of all online CPD workshops can be found on the GSSA YouTube channel.

SA Candidate Mentoring Programme

The Candidate Mentoring Phase (CMP) programme is headed up by Noleen Pauls and has been successfully running since 2020.

Between July 2021 and June 2022, 10 SACNASP candidates were enrolled in the GSSA/SACNASP Candidate Mentoring Programme (CMP). Due to continuing COVID-19 restrictions, few of the planned networking events went ahead. Nevertheless, the mentors and mentees managed to advance the programme through various online platforms. The sponsorship provided by SACNASP has meant that the mentees were able to attend all of the online GSSA events last year.

Noleen Pauls

all the news fit to print

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

University of the Witwatersrand

The School of Geosciences would first of all like to congratulate Prof. Tamiru Abiye on winning this year's NSTF South-32 TW Kambule NSTF Research Award for his dedication to water science, where he has focused on building research capacity and solving community problems to promote sustainable development in SA.

Other winners within the School, announced at the GSSA's AGM, were Dr Stephanie Scheiber-Enslin,

Prof. Tamiru Abiye pictured with his award.

Prof. Musa Manzi and Prof. Susan Webb who were presented with the Jubilee Award for the best paper published in the *South African Journal of Geology* for 2021. Their paper is titled "Seismic Imaging of Dolerite Sills and Volcanic Vents in the Central Karoo, South Africa: Implications for Shale Gas Potential" (Vol 124 (2), 465-480). The SACNASP Award, which recognises an exceptional 4th-year student in Earth Science at a Southern African university, was presented to David Russo (supervised by Prof. Gillian Drennan) for his project "The Nature and Origin of Carbon Nodules in Precambrian Granite/Gneiss Terrains with Specific Reference to the Konsberg Region in Norway".

Last but not least on the awards front, Profs Judith Kinnaird and Paul Nex were jointly awarded the Draper Medal. This is the highest scientific award of the GSSA, and recognises an exceptional member of the geological profession who has excelled in the advancement of South African Earth Science. This award was rather bitter-sweet as we will miss Paul and Judith immensely, but wish them both well on their new adventures back in the UK.

Continuing with the theme of new adventures, the School would like to reiterate its welcome to both Dr Scott Maclennan and Dr Karen Smit, who joined us in the last couple of months as new academic staff.

The NuSapphire (pictured on the right) has a dual-ion pathway that allows for classic isotopic analysis via a high-energy ion path, as well as a low-energy collision-cell pathway that reduces the isobaric Ar interferences from the plasma and allows for measurement of more interference-prone isotopes (S, Ca, K, Fe). This collision-cell feature allows for a much more versatile range of isotopic measurements to be made—either in solution or in situ—for which there is great scientific demand in Southern Africa. The NuSapphire will be used to measure traditional radiogenic isotopes (Rb-Sr, Sm-Nd, Lu-Hf, U-Pb) as well as heavy, stable (or non-traditional) isotopes (Fe-Cu-Zn, Mg, Ca-Sr-Fe, multiple S). The NuTIMS instrument (pictured on the Left) will complement the NuSapphire by providing unparalleled isotopic precision, particularly where sample concentrations are very low. This will be achieved using a thermal ionisation source coupled to a 16-channel multi-collector array with Faraday, electron multiplier and Daly detectors for ultra-high-precision measurement of radiogenic systems like Rb-Sr, Sm-Nd, U-Pb and Re-Os.

Some of you may be aware of the renovations currently being done to the lower-ground floor of the Geosciences Building—this was largely incentivised by the need to make space for two state-of-the-art isotope-ratio mass spectrometers from NuInstruments: a Collision Cell Multi-Collector-ICP-MS (NuSapphire) and a Thermal Ionization Mass Spectrometer (NuTIMS). Our new instrumentation was made possible through an NRF National Equipment Program grant (along with Wits University cofunding), which was awarded to Profs Robert Bolhar and Grant Bybee. This combination of instruments does not exist elsewhere on

☞

the African continent, and will complement the ultra-clean, metal-free, isotope geochemistry lab already within the School, along with the existing LA-ICP-MS system (Thermo Element XR) and quadrupole ICP-MS (Thermo iCAP Q). This versatile combination of isotope-ratio instrumentation will allow researchers and students to generate cutting-edge, multidisciplinary isotopic data. All of the isotope systems that these instruments can measure will provide critical analytical techniques for economically important ore deposit research in Africa, as well as many other research disciplines spanning the Earth Sciences.

The Advanced Mass Spectrometry Lab, containing all of the School's mass spectrometers, will be operational from late-2022 and will be run by a cross-disciplinary team: Profs Robert Bolhar and Grant Bybee, along with Drs Karen Smit and Kimberley Beaton. If you are interested in utilising our instrumentation in your research, please email our team: robert.bolhar@wits.ac.za / grant.bybee@wits.ac.za / karen.smit@wits.ac.za / kimberley.beaton@wits.ac.za.

We will keep you updated on progress regarding our new Earth Observatory—a world-class facility to house our broad array of geoanalytical instrumentation!

Our postgrad students have also been keeping busy, most recently with a SAS-SEG-organised field trip to the Northern Cape, specifically with visits to the Okiep copper project, Jubilee pit, Orbicular Koppie and Vedanta core yard.

For those who might not be aware, SAS-SEG (the South African Student chapter of the Society of Economic Geologists) is a self-funded, student-run society that comprises members from both the University of the Witwatersrand and the University of Johannesburg. The primary purpose of the organisation is to develop the knowledge and skills of their members in the field of economic geology so that they are industry relevant. This is done by hosting geology-themed talks, short courses, networking events and field trips, such as this year's trip to visit Cu-Zn-Pb deposits outside the typical university teaching programme.

Mr Kamogelo Duiker, a geophysics MSc student at Wits, and Ms Justine Magson, a geology PhD student at the University of the Free State, were both selected to participate in the "ICDP training course on Continental Scientific Drilling" to be held 25–30 September 2022 at the Geocenter KTB in Windischeschenbach (Germany). This exciting program will touch upon all relevant aspects of continental scientific drilling, including project planning and management, pre-site surveys, drilling engineering, sample handling and storage, on-site studies, downhole logging, data management, post-drilling measures, as well as outreach. The training is directly relevant to their studies as they are both

Celebration dinner with Vicky and Alex Wagner (Wirsam Scientific), Daniel Thomas and Kirsty Young (NuInstruments), Robert Bolhar, Grant Bybee and Karen Smit (School of Geosciences, Wits University).

Field discussion led by Conrad Louw van Schalkwyk (yellow shirt) a few metres from where the Okiep copper project took place.

working on projects related to the Bushveld Drilling Project (BVDP), a project of the International Continental Scientific Drilling Program (ICDP). In preparation for the German experience, Kamogelo attended the GSSA drilling course presented by Colin Rice.

Lastly, the School is excited to announce that as part of Wits' centenary celebrations we will be hosting talks from alumni working in industry and academia, highlighting their career journey and current work. The speaker line up is as follows:

July 28th Richard Viljoen
August 4th David Mosuwe
August 11th David Khoza
August 25th Valerie Nxumalo
September 1st Priyal Daya and Bavisha Koovarjee
September 8th Libby Sharman
September 15th Trishya Owen-Smith
September 29th Itumeleng Mogatusi

And finally, to cap off the celebrations the School will be hosting a Wits Centenary Geosciences Alumni Lunch on Saturday 24 September, at 12 pm. More details to follow, so please complete this Google Form so we can keep you updated https://lnkd.in/dmgpkkD4 and if you have any questions, contact Kimberley.Beaton@wits.ac.za.

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

SAS-SEG members at Vedanta core yard. From left to right: Agex Manuel, Daniel Bussin, Simona Poelinca, Bibi Ayesha Jogee (President), Dakalo Maphanda, Kiyuren Naidoo, Malaika Motsoai, Dr Scott Maclennan, Peace Zowa (Treasurer), Senamile Dumisa, Kebone Maselela, Loane Malelu, Dr Ben Hayes. Other members of the committee not pictured are: Mfuneko Sihlezana (Vice President) and Matthew Hales (Secretary).

branches & divisions

Western Cape Branch

The GSSA Western Cape Branch hosted the first field trip of the year in late June, where a few of our members took part in The Umvoto Foundation's (TUF) Table Mountain Dams Trail, which coincided with the official launch of the completed guidebook for the trail. The inaugural hike for the trail was undertaken in early April, as part of the GSSA's Geoheritage 2022 conference. The trail traces the history of the construction of the five dams on Table Mountain, the geology of the iconic Cape Peninsula mountain range, and the repeated water shortages of the southwestern Cape that have driven Cape Town's engineered water supply over the past few centuries. The hikers (pictured) were led by Umvoto's Paul Lee, with aid of the accompanying guidebook and interactive map/trail on the Forge app, as they explored the wonders of the Table Mountain National Park and visited various historical and (hydro)geological points of interest. With the use of existing trails in the park, the group experienced a unique narrative on the characteristic landmark, as they climbed from Constantia Nek car park up

GSSA Western Cape Branch members at the Woodhead Tunnel, a stop along the Table Mountain Dams Trail.

Group from the inaugural Table Mountain Dams Trail hike (as part of GSSA Geoheritage 2022), walking along Victoria Dam on the Back Table.

Orange Kloof and the Disa Gorge (one of the lesser trodden trails of Table Mountain), along the Back Table, and down the Jeep Track. This trail marks the first in the TUF geotrail/geoheritage series, and through the continued support of the 35th IGC Legacy Fund and GSSA, TUF plans to expand these self-guided (hydro)geoheritage initiatives to the broader Western Cape (with the next trail in development being the "Hermanus Water Walk"). Visit theumvotofoundation.org to find out more.

the geological hot pot

We begin by taking you deep down under the deep blue sea, into the realm of submarine canyons and the sedimentary processes that take place in them. These canyons have been carved into continental margins and are the conduits that facilitate the transfer of sediment from land to the abyssal ocean floor. The sediment ultimate settles out as turbidite deposits. Two recent open-access articles in *Nature* discuss details of the geological processes that take place in submarine canyons. These canyons are fed with sediment by rivers or longshore drift. The recent post-glacial sea-level rise has disconnected more than two-thirds of the world's submarine canyons from their sediment sources and has led to the assumption that these land-detached canyons are currently dormant. Monitoring of the Whittard Canyon off the coast of Brittany in France has, however, shown that this is not necessarily so. Novel instrumentation has detected turbidity current activity, the open-access report on which can be downloaded here. The conclusion is that cognisance should be taken of turbidity current activity in land-detached submarine canyons, and not just those in the ones still attached to their sediment sources.

A bit closer to home is the report on the longest turbidity current flows yet measured on Earth, off the mouth of the Congo River. It is almost unimaginable that a single flow can be over 1 130 km long, three-quarters of the distance from Johannesburg to Cape Town. Yet this was measured in the Congo Channel! The study, reported *in Nature*, highlighted the efficiency of sediment transport from land to abyssal plain through submarine canyons.

Graded meta-sedimentary rocks, interpreted as turbidites, from the Damara Sequence in central Namibia.

It goes without saying that exploration geoscientists are always keen to discover new ore deposits that are mined for the benefit of all. Research that increases the chances of locating such ore deposits is thus important in the mining chain, and three such endeavours have recently been reported. We are all acquainted with the concept of plate tectonics in the context of how the Earth functions at a fundamental level. Geoscientists in Australia and the USA have published an updated map of the Earth's plate boundaries, as reported in SciTech Daily. This article has a cool animation of the plate boundaries that is worth watching. One boundary type—subduction zones—is associated with many types of economically important mineral deposits. How, why and where these form is thus important to know when searching for them.

Gossan of an oxidised massive sulphide deposit in the Matchless Amphibolite Belt in Namibia. The deposit is believed to have formed at a spreading plate boundary, a modern example of which is the Red Sea.

A study on the water content of plutons in the western Himalayas using secondary ion mass spectrometry found that the amount is almost double that previously reported, up to 8 weight percent. This high water content explains why many volcanic eruptions are explosive, and is also significant for the potential to form hydrothermal ore deposits. A summary of the study is available at SciTech Daily.

Another control on ore deposit fertility of subduction zone magmas is reported *in Nature*. The silicate melt inclusions in Southern Andean volcanic rocks show an increase in sulphur and chlorine and decrease in copper from the south (fertile rocks) to the north (barren rocks). This suggested to the authors that the fertility of the hydrothermal-magmatic porphyry system is not controlled by the concentration of copper, but rather the sulphur and chlorine contents.

A hot pot is all about cooking, and a particular type of "cooking" has given rise to all the minerals that we know of today. Robert Hazen of the Carnegie Institute for Science in Washington DC is at the forefront of a study of the evolution of minerals, and this piece on the BBC website beautifully reports on his latest paper. It's all about the chemistry, what you react with what, and lubricated predominantly by water. Although some minerals can be "cooked" with quite a few different chemical processes and pressure–temperature conditions, about 59% form under unique physico-chemical conditions. At one extreme, pyrite can be formed in 21 different ways, while spheniscidite (crystallised penguin poop) can form in only one way!

No hot pot is complete without a filet (or other part) of dinosaur. A huge mass extinction occurred at the end of the Triassic era about 202 million years ago. This caused the demise of the reptiles and heralded in the dominance of dinosaurs in the succeeding Jurassic period. Dinosaurs evolved during the Triassic period that was overall climatically hot and humid. Similar conditions also occurred in the Jurassic period, and so it is generally assumed that all dinosaurs loved heat and moisture. Newly discovered fossils in northwest China in the Junggar Basin, however, provide evidence that some dinosaurs thrived under cold conditions. This is important because one theory about the cause of the Triassic–Jurassic mass extinction invokes extremely cold conditions caused by major volcanic eruptions in Siberia. If this was the case, then the survival of the dinosaurs as a group is due to some of them being already adapted to living in such cold conditions. You can read more in this article in SciTech Daily.

Culprit responsible for spheniscidite on Boulder Beach, Simonstown.

How would you go about drilling a hole in hard rock? You could use conventional percussion drilling, where you use a drilling hammer head to break the rock, or diamond core drilling using an abrasive head to cut through rock. In the course of geothermal energy research, it became evident that deep underneath our feet there are hot rocks that can be tapped for such energy. The technical problem is to drill deep enough holes, down which cold water can be pumped and returned to the surface as steam to drive an electricity-generating turbine. A spinout of the Massachusetts Institute of Technology (MIT) is experimenting with using a microwave-emitting device, called a gyrotron, to literally vaporise rock and thus create a hole.

Dropstone in glacial varves near the top of the Dwyka Group southeast of Dundee in KwaZulu-Natal. The Dwyka was deposited during the widespread Permian glaciation when Africa was part of the Gondwana supercontinent.

The concept has been tested, and the results are discussed in SciTech Daily. If the scaling-up of the laboratory experiments is successful, it would be a game-changer in drilling technology, and a great step forward in the feasibility of geothermal energy worldwide.

Two feel-good snippets to end the column. An article published by the American Psychological Association, and summarised here, suggests that we, as humans, enjoy being reached out to by friends and acquaintances. Especially when it is out of the blue. So go out now and call someone! (Please not me… as yet). And one for cat aficionados. Have you ever wondered why cats are so attracted to catnip? It turns out that catnip contains chemicals that ward off insect attacks, and our clever feline companions have made use of this fact to do exactly that… Read all about it here. Until next time, meowing off.

George Henry

Conventional percussion drilling rig in action in the Karoo region during the height of uranium exploration in the late 1970s.

Friendly feline well known to University of Johannesburg Geology Honours students. Resident at Klein Pella. Picture taken in September 2018; still active in November 2021.

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anniversary

Arthur William Rogers, FRS (1872–1946), pioneer in the geological mapping of the Cape of Good Hope

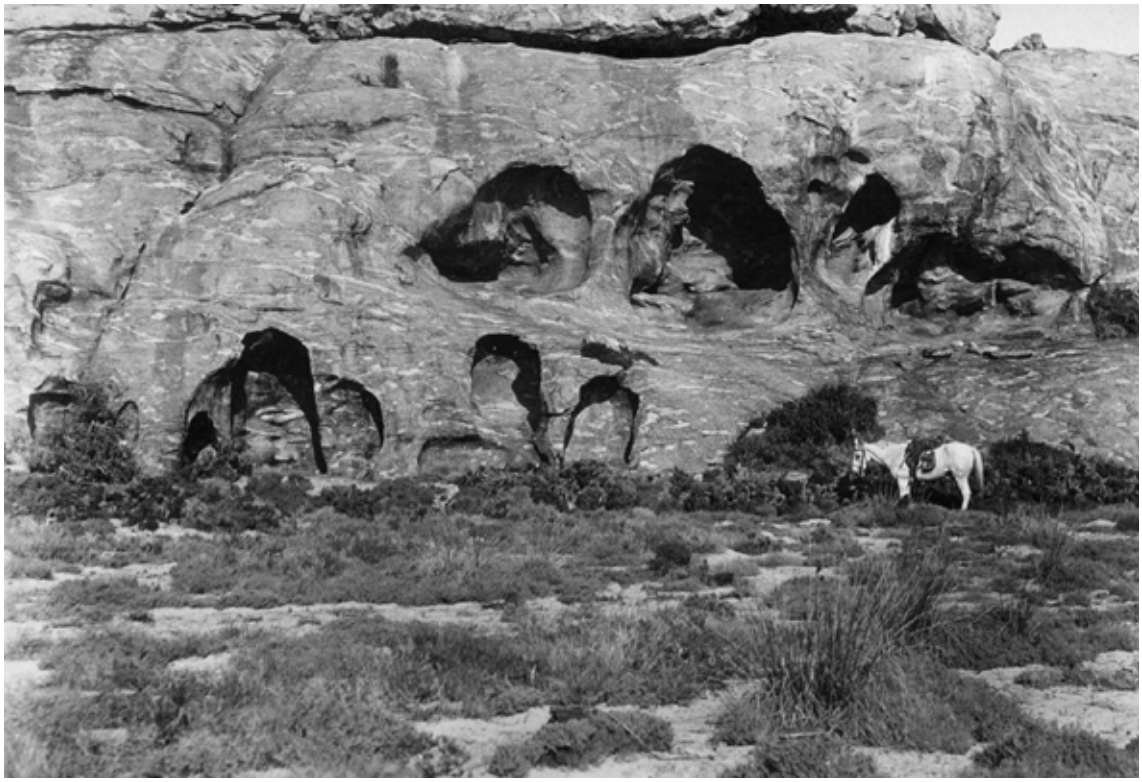
Modern South Africa was formed by the political union of the former British colonies of the Cape of Good Hope and Natal, and the former Afrikaner Boer Republics of the Transvaal and the Orange Free State, in 1910. Until the last decade of the 19th Century, there had been no standardised geological mapping in South Africa, only scattered work in different parts of these four territories by state-appointed geologists. Systematic geological mapping, resulting in the production of standard geological maps, started in the Cape with the establishment of the Geological Commission for the Cape of Good Hope in 1895. This was followed by other state surveys in Natal Colony and the Transvaal Republic. The first Director of the Commission was Dr George S. Corstorphine, under whom were two field geologists, Arthur William Rogers and Ernest Schwarz. Rogers started his career with the Geological Commission, working his way up from Field Geologist to Director, until he was eventually appointed Director of the Geological Survey of the Union of South Africa. He was one of the most distinguished of the early pioneers in the geological mapping of South Africa. He was also the first historian of the pioneers of South African geology. Most of our information concerning Arthur Rogers is derived from several obituaries published by his one-time colleague and protégé, and lifelong friend, Alexander Logie du Toit, who joined the Geological Commission of the Cape of Good Hope in 1903, working together with Rogers and Schwartz.[1–5]

Arthur William Rogers was born on 5 June 1872 in Bishop's Hull, near Taunton, in Somersetshire, England. He attended Clifton College in Bristol (1885–1891), where he came under the influence of geologists John G. Grenfell and George Wollaston, and the biologist C. Lloyd Morgan, who had taught at "Bishops", the Diocesan College in Cape Town, and had a keen interest in geology. Rogers was at Christ's College, Cambridge, from 1891–1895, obtaining his BA in geology and zoology. Here he was taught, among others, by Adam Sedgwick, Alfred Harker, Albert Seward and Philip Lake, and developed lasting friendships with Frederick R. Cowper Reed, Robert Heron Rastall, and J. Graham Kerr. In later years Seward studied fossil flora of the Cape, while Lake studied the trilobites, and Cowper Reed the molluscs and brachiopods, of the Bokkeveld Beds. In 1895, Rogers commenced geological research on Lundy Island, Devon, but was then recommended for a post at the newly formed Geological Commission of the Cape of Good Hope, by Prof. James Geikie, of the University of Edinburgh.

Arthur William Rogers (1872–1946) (photo: du Toit[4]).

Garies (Namaqualand) from the South End (photo: A. W. Rogers; UCT, Jagger Library).

Rogers arrived in South Africa in 1896, commencing work with the Geological Commission as an Assistant Geologist, together with Ernest Schwarz. Together and separately, they mapped the Palaeozoic rocks of the south-western Cape, from 1896 to 1902. These Palaeozoic rocks are folded in the Cape Fold Belt and consist of strata of what are known today as the Cape and Karoo Supergroups. Rogers spent most of 1902 on long leave in the United Kingdom. In 1903 du Toit joined the commission, replacing Schwarz, and he and Rogers continued mapping in the northern part of the Cape of Good Hope, extending their mapping to the basement rocks underlying the Karoo basin (including what are now known as the granites and gneisses of Namaqualand, and the Ventersdorp and Transvaal Supergroups). Rogers' own photographs from those early years of the 20th



Caves in gneiss, left bank of Spoeg River (Namaqualand), 1 mile from mouth (photo: A. W. Rogers; UCT, Jagger Library).

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June circular

Despite all the delays that Geocongress has experienced over the last two years, we are very pleased to announce that over 90% of the original sessions, field trips and workshops are being retained in the January 2023 version of the event! This is an excellent testament to the enthusiasm for the event displayed by our esteemed colleagues within the southern African earth sciences community.

To further enhance the conference's offerings, a call for additional sessions, workshops and field trips is currently open until 20 June 2022. Once these additions have been finalized, the abstract submissions portal will open on **1 July 2022**. Additional information is available at the conference website https://allevents.eventsair.com/geocongress/ which will be updated periodically.

Confirmed workshops:

Gold geology	Neil Phillips	2 days
DSI-NRF CIMERA workshop	Nikki Wagner	half day
Pressure-temperature constraints, phase equilibria and open system modelling of geological processes	Matt Mayne	1 day
3D geological modelling	Ian Basson (TECT)	

Confirmed field trips:

Rock Around the Overberg - a 600 million year geological tour along the southern Cape Coast	John Bristow	3 - 5 days
Terroir in the Cape Winelands	Western Cape SEG student chapter	half day
Geology of the Malmesbury Group and Cape Granite Suite of the Pan-African Saldania Belt	Alex Kisters, John Clemens	2 days
Cape Fold Belt and Karroo	DeVille Wickens	4 days
Namqualand geology	Paul Macey	5 days

To suggest any further workshops or field schools, please email Prof Alex Kisters directly (akisters@sun.ac.za)

Environmental	Geobiology
	Acid mine drainage and other mine pollution issues
	Environmental Geochemistry
	Geoscience for a sustainable energy-environment nexus
	Current and future outlook for Carbon Capture and Storage in South Africa and abroad.
	Advances in Southern African Hydrogeology
Energy	Future of petroleum geosciences in Southern Africa
	Solid fossil fuel resources
Igneous	Diamonds, kimberlites and cratonic lithosphere: a session in honour of John J. Gurney
	Advances in Bushveld Petrogenesis and Ore Genesis
	Igneous beyond the obvious
	Felsic rocks of the Bushveld complex: Petrogenesis and metallogeny
Metamorphism	Differentiation of the Earth's crust at the metamorphic:igneous interface
Earth Evolution	Archaean Processes and Environments
	The Proterozoic of Africa
	Central Africa
	Africa's Phanerozoic tectonic evolution and associated magmatism
Planetary	Planetary Geology: Earth, Moon and Beyond
Ore	Applied Mineralogy Session
	Sediment-hosted ore deposits
	Ore-structure relationships
Sedimentary	Detrital Zircon: Methods, problems, applications
	Sedimentary basins in Southern Africa
Society	Geoscience and society
	The Future Geoscientist

To suggest any further sessions, please email Bjorn von der Heyden directly (bvon@sun.ac.za)

Century reveal how undeveloped Namaqualand and the Karoo was then. Among Rogers' important discoveries, aside from the stratigraphy and structure of the Cape Fold Belt, was the recognition of important pre-Carboniferous glacial beds in the Cape rocks, within the Table Mountain sandstone (the Ordovician Pakhuis Formation) and the Precambrian Numees tillites (Neoproterozoic). By 1905, Rogers had accumulated enough geological evidence through his mapping activities with the Geological Commission to publish the first book on the geology of the Cape of Good Hope,[6] in which the palaeontologist Robert Broom provided a section on the fossil vertebrates. That same year, Rogers presented a summary of the "Geology of Cape Colony" at a joint meeting of the British and South African Associations for the Advancement of Science in Cape Town.[7] Within a few years, this book went into a second edition.[8] The three authors associated with this book, Rogers, Broom and du Toit, all became Fellows of the Royal Society, but Rogers fell out with Broom over Broom's sale of Karoo vertebrate fossils to the American Museum of Natural History, and they were never reconciled, and du Toit acted as the middle man between them.[9] In 1914, Rogers was invited to join the expedition in Deutsch Südwestafrika (now Namibia) of German geography professors Fritz Jaeger and Hans von Staff. This enabled him to compare the geology of the regions north and south of the Orange River, and to study the Brukkaros Mountain, an ancient volcanic complex. Rogers' various reports on Cape geology were published mainly in the Annual Reports of the Geological Commission of the Cape of Good Hope, and in the Transactions of the South African Philosophical Society (see Bibliography in du Toit[4]).

In 1916, Rogers was appointed as Director of the Geological Survey of the Union of South Africa, and moved to its headquarters in Pretoria, in Transvaal Province. He became involved in the mapping of the gold-bearing Witwatersrand beds near Heidelberg.[10,11] He also started with mapping of the Klerksdorp goldfield, but then became mainly involved with administrative duties. In 1929, Rogers became the President of the International Geological Congress, which was held for the first time in Africa, in Pretoria. In time for this Congress, he edited a book on the regional geology of South Africa.[12] In 1930, he joined the Vernay-Lang expedition that departed Mafikeng,

Post cart at Wallekraal, Karoo (photo: A. W. Rogers; UCT, Jagger Library).

and travelled through the Kalahari of Bechuanaland (now Botswana) and South-West Africa (now Namibia), before ending up in Livingstone in Northern Rhodesia (now Zambia). His research resulted in two papers on the "solid" and surface geology of the Kalahari.[13,14] Rogers retired from the Geological Survey in 1932, and moved to his home in Mowbray, Cape Town, where he continued his research on diatoms in diatomaceous earth found in pans (published posthumously[15]). He garnered many awards, honours, and honorary degrees during his distinguished career, and they are tabulated in detail by du Toit.[4] In his retirement years he produced the first history of the geological pioneers of South Africa,[16] a work that du Toit regarded as Rogers' crowning achievement.[4] He suffered from a debilitating heart attack in 1939, but continued working intermittently on his diatom memoir until he died on 23 June 1946.

Acknowledgements

I am grateful to Clive Kirkwood (Special Collections, Jagger Library, University of Cape Town) for permission to reproduce the photographs by Rogers.

Sharad Master

Vice-President for Africa: IUGS International Commission on the History of Geological Sciences (INHIGEO)

School of Geosciences, University of the Witwatersrand

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geoheritage

3.6 billion years of Geoheritage in South Africa—and some 25 years of GSSA Geoconservation: A personal appreciation

That southern Africa, and especially South Africa, represents a subcontinental region of exceptionally long geological evolution is known to every reader of this article. On 24 September 2022, Heritage Day will be celebrated again in South Africa, for the 28th time. Heritage Day is a national holiday created by the government to celebrate this country´s "cultural and living heritage" (as I could glean from numerous websites). However, *de facto*, South Africa´s *natural heritage* has been fielded on this day as well—ever since 1995 when this holiday was inaugurated. Many events by the Geological Society of South Africa (GSSA) and other organisations have celebrated this country´s geoheritage over these years. Thinking back to those mid-1990s, it was just around the time of this creation of (another) South African holiday that discussions within the GSSA led to recognition of the need to promote South Africa´s natural heritage—its geological heritage—and to embrace the task to care for it.

The southern African region contains a great diversity of geological resources—but then, how dare I preach this to those in the know. In 2006 we summarised this gigantic resource as *"a virtual geological wonderland. With the exception of active glaciers and volcanoes (though both these environments can be studied in the stratigraphic record of the Karoo Basin, . . . every geological process can be observed, covering a time span of 3600 million years . . . This includes the evolution of the Earth, since the formation of the 3500 million year nucleus of an Archaean continent, with microfossils of some of the earliest lifeforms on this planet, to the presently active beach processes and desert development. The coastline of South Africa and its scenic coastal mountain ranges provide fine examples of processes related to continental drift, the collision and splitting apart of crustal plates, and the formation of continents over hundreds of millions of years*." [1(pp44–46)]

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In the mid-1990s, the Council of the GSSA began to discuss a number of calls from members and Regional Branches that emphasised the need to highlight South Africa´s enormous wealth of geological, palaeontological, and archaeological heritage. More and more calls expressing concern about the lack of necessary protection were received. Legislation at the time made provision for declamation of Natural Monument sites, such as the famous Dwars River National Monument (more recently called a Heritage Site) in the Eastern Bushveld, which in theory would have been under legal protection already in those years. Other sites had been plaqued "Geosites", an informal undertaking that while not offering protection, at least afforded some recognition in the public realm. Notably, in 1995 it had already been some 8 years since the Tswaing Crater of meteorite impact origin in northeast Gauteng was declared a protected site. Tswaing had been earmarked since before 1988 for development into a museum and geo-education centre. Now, 27 years later, I must lament that a formal recognition of this unique geoheritage site has still not been achieved. Let us not talk about the ill fate of the burned-out Tswaing Crater Museum…

Geoheritage and later Geotourism and Geopark concepts were widely and internationally discussed in the mid-90s, as a direct consequence of several benchmark conferences, such as the 1993 Malvern International Conference on Geological and Landscape Conservation in the UK. In fact, the term "geological heritage" was first mentioned at the First International Symposium on the Conservation of our Geological Heritage,

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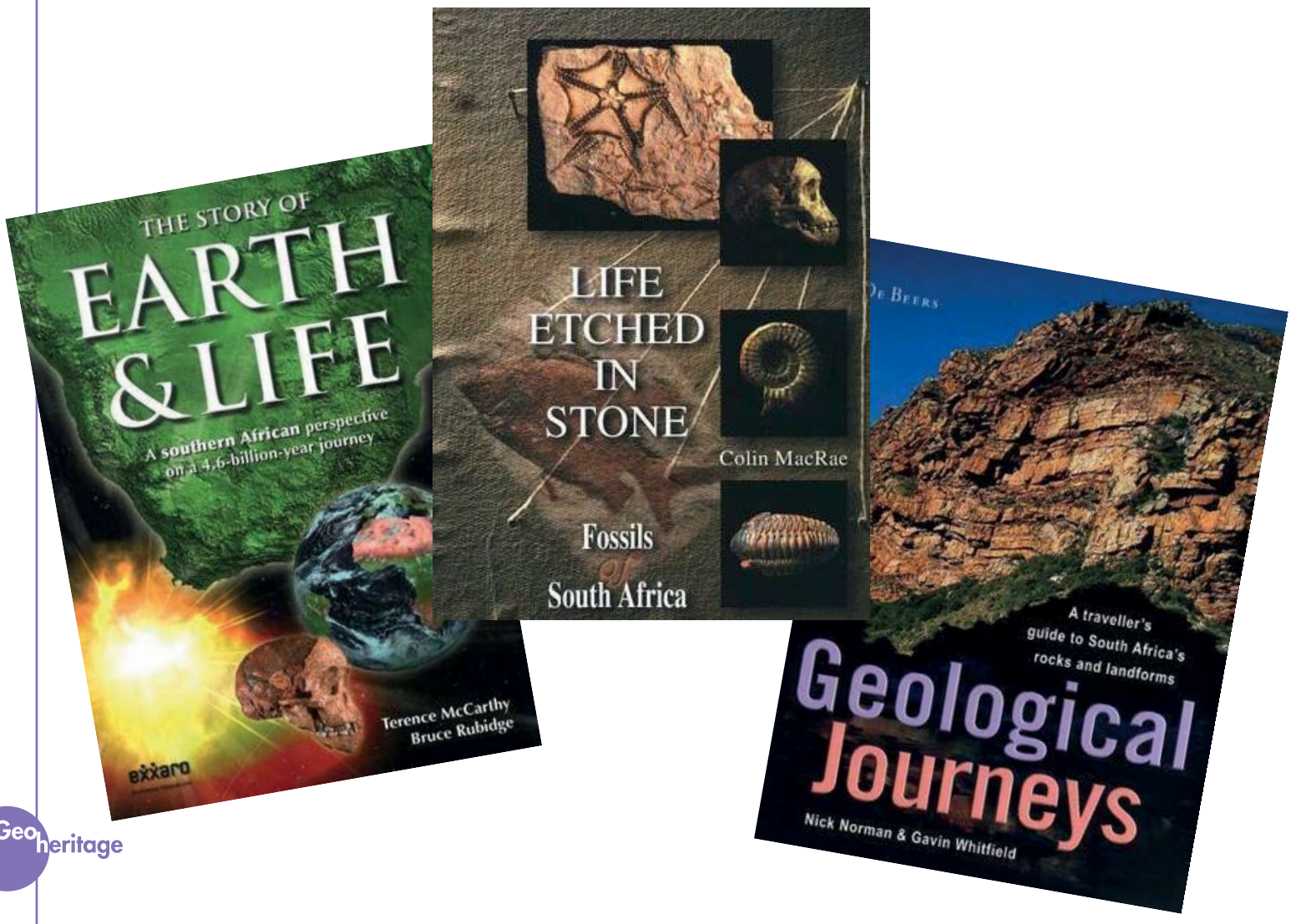
which took place at Digne in France in 1991, where the Digne Declaration on the Rights of the Memory of the Earth was conceived. Since that conference, *"significant progress has been made by numerous countries to protect and conserve geodiversity... via national programmes aimed towards the protection and promotion of geological sites or areas. One of the recommendations in response to the signing of the 'Declaration of the Rights of the Memory of the Earth' was the creation of a global network of geological territories seeking the support of UNESCO, by integrating geodiversity into its mainstream activities*."[2(p274)] This was, indeed, the hour of birth of the UNESCO Global Geoparks Network.

Nearly contemporaneously, geological heritage and geotourism concepts were developed in many countries, *inter alia* in Australia, the United Kingdom, Spain and Italy, Indonesia and China, in Germany and elsewhere—a wildfire of development that spread across the globe within a handful of years. Geotourism can be defined as knowledge-based tourism, an interdisciplinary integration of the tourism industry with conservation and interpretation of nature with related cultural, historical and biological issues, at geosites/areas specially developed for the general public. This concept was, then, rapidly taken further towards the generation of special geosites that had the potential to become National, or even Global, Geoparks—the latter under a UNESCO statute. A European Geopark class was also introduced. Notably, in all these countries, national legislation was generated that would provide legal frameworks and administrative basis for protection, management, certification, and sustained development of geoparks.

In the follow-up of the paradigm shift in South African politics at the beginning of the 1990s, conservation- and tourism-oriented drives became



Geoheritage

fortified. Government saw tourism as a vehicle for economic growth and people´s empowerment. The following decade did prove them right, when tourism influx increased multifold. The GSSA, in 1995, chose the apt motto *'South Africa—Land of Geological Superlatives'* for its Centenary Geocongress (Geocongress ´95). And in the same year, the Society formally established a new Interest Group, the Conservation and Geoheritage Committee, which over the years developed into a fully fledged Division of the Society, now known as the Geoheritage Division. Several GSSA branches embarked on conservation activities and occasionally even appointed Geoconservation Officers. A new geosite was declared at the famous Sand River Gneiss near Messina, and work on a Rock Garden in the Roodepoort (now Walter Sisulu) Botanical Gardens began. However, it was recognised at the time that the Committee was only in possession of a limited database, with some meagre records of exceptional sites and areas in need of promotion and conservation.

From 1996 on, a new National Heritage Conservation Act was drafted by national government, in consultation with numerous stakeholders, including several learned societies and the mining industry. The GSSA actively supported this process, with the explicit mandate for its representatives to ensure that exceptional geological heritage would be entered into legislation (besides meteorites and precious minerals that had already been considered). This process culminated in the 1999 declaration of the National Heritage Resources Act, with its subsequent divulsion of heritage administration and development from central government to lower, provincial and municipal, levels. Serious concern was voiced at the time about how these hierarchies were staffed with expertise in the field of heritage management, as well as regarding the highly varied knowledge required on the different types of natural and cultural heritage brands.

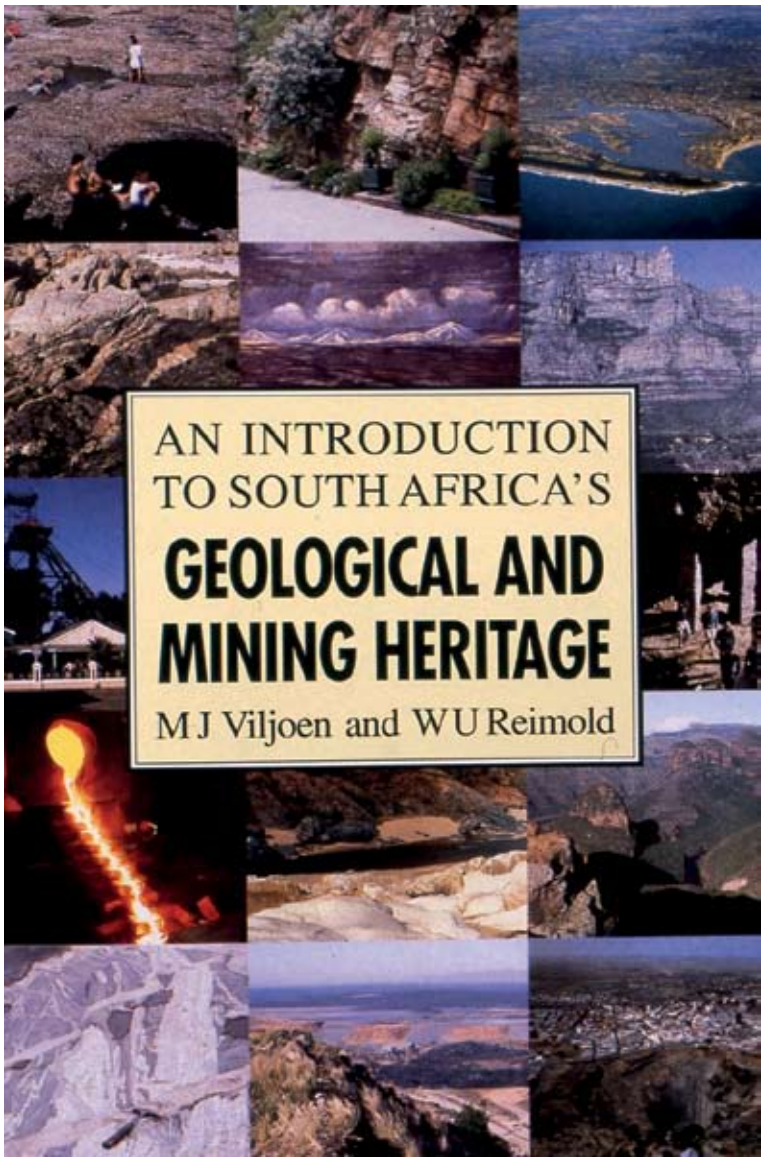
Against this backdrop of international and national activities, the GSSA´s Geoheritage Committee convened a first Workshop dedicated to brainstorming the South African geological heritage and its potential for resource development at the University of the Witwatersrand on 7 March 1997. Topics debated included inventory and promotion of SA´s geoheritage conservation measures—in place or to be developed—and how to approach the thorny issue of interesting the political sphere, as well as the broader public, in these aspects. I recall that some 40—50 participants took part in this symposium, with representation of the National Monuments Council, several GSSA regional branches, a few provincial administrations, the Council for Geoscience, and interested members of the Society. National government was represented by the Department of Environmental Affairs and Tourism. Regional Branches of the Society were represented and informed about their special heritage sites—some already recognised as National Geosites, others still in slumber. Bill Wimbledon of PROGEO, the European Association for the Conversation of the Geological Heritage, informed us about international geoconservation efforts.

One thing was obvious at this symposium: We all knew of sites or areas of special geological importance—such as Dwars River, the early Archean komatiites of the Onverwacht Group and the tidal deposits of the Moodies Group, the Vredefort Dome, the Tswaing crater, the famous sites in the Western Cape, and archaeological and palaeontological richness of many other regions in South Africa. Langlaagte was designated a special site in the Witwatersrand mining district in Johannesburg, and a host of other special mining or geological sites were related. Some information was also transmitted about pending legislation. Now, in hindsight, I am wondering why we did not more actively approach the representatives of governmental agencies, right from the start…

One of the main findings at this workshop was that it was mandatory to generate a national database of South Africa´s geoheritage, a proper documentation of all important geological, palaeontological,

archaeological, and mining geological sites. It was proposed that this task of obviously vast scope should be taken on by the Geological Survey, i.e., the Council for Geoscience. Regional branches of the GSSA undertook to assist with this national task with compilations of regional registers (based on a report in *Geobulletin* v. 40, 1997).

In 1997–1998, much debate ensued about how to enthuse the public communities as well as governmental agencies about the need to conserve our geological heritage. The country was opened to prospecting and exploration, and illegal mining activities increased considerably. A few of us thought that placing geological heritage and geoconservation in the public eye would assist in drawing some attention from national structures.



The Book!

At one point a delegation of the GSSA´s Committee visited the Minister of Environmental Affairs and Tourism in Pretoria. We presented some ideas about geoconservation, also in the interest of contributing to tourism development in the country. The then Minister advised us, however, that it would be better for tourism to have 5 game parks than one mountain range—to which I (probably in my typical diplomatic way) responded that having 5 protected mountain ranges with game parks would certainly be better for tourism… Needless to say, the meeting was soon adjourned.

A project was developed within the GSSA´s Committee whereby a significant collection of geological and mining heritage sites would be presented in a small handy booklet format (not an intimidating 300-page tome or a coffee-table-book-like investment), to illustrate and inform about the entire country´s geological riches, their relationships to mining history and industry, and as a public, school, or even student education medium. In fact, it was hoped to create an introductory text and field guide. Morris Viljoen, in his inimitable enthusiastic way, strongly embraced this project. He found strong supporters and eventual sponsors of this project in the then directors of MINTEK, Aidan Edwards and Paul Jourdan. Yes, I am talking about the *Introduction to South Africa´s Geological and Mining Heritage*,[3] which was published jointly by the GSSA and MINTEK, benefitting from extensive support from the 1999 National Year of Science and Technology through the Department of Arts, Culture, Science and Technology. Anthony Cowey of MINTEK expertly managed the book production and technical aspects of layout and printing. Many colleagues from academia, Council for Geoscience and the mining sector did not hesitate to provide information and imagery, so that the final product turned into a true team effort, with contributions from all parts of the GSSA family. This unpretentious but content-rich booklet was first printed in 1999, and 5000 copies of it were donated to high schools throughout the country. Numerous copies were acquired in the open book market, nationally and internationally.

Geovandalism through drilling for palaeomagnetic research in the Songimvelo Game Reserve, Mpumalanga (scale in cm).

A second print-run was already required in 2002, its appearance coinciding with the World Summit on Sustainable Development in Johannesburg. It did not last long on the shelves either…

I dare to conclude that this little booklet was a trigger for a host of further geology- and geoheritage-inspired publications, such as the *Story of Earth and Life* by Spike McCarthy, Bruce Rubidge and their team, with its tens of thousands of copies sold. Or the highly successful books by Gavin Whitfield and Nick Norman themed *Geological Journeys*. The Geological and Mining Heritage book was intended to inspire school kids, students, and all others; to highlight South Africa´s natural riches and their formation, and to remind of the need to look after it.

In the same year (1999), another little pocket-book was produced on the *Tswaing Meteorite Crater*,[4] which eventually went into numerous schools as well. It was intended as a natural history about a fascinating site, within a huge semi-formal to informal community, in dire threat of being swallowed by informal settlements, but also providing a huge opportunity as a site museum and educational area. The Council for Geoscience published the little volume, which did well and was widely disseminated—until remaining stock was unceremoniously dumped.

But let us move on to another topic: World Heritage Sites! South Africa did subscribe in 1997 to the UNESCO World Heritage Convention. From 1999 until 2021, not less than 10 WHS have been instituted for South Africa. Of these, 8 sites have direct geological components in their heritage descriptions (fossil hominid sites at Sterkfontein, 1999; Mapungubwe Cultural Landscape, 2003; Richtersveld, 2007; iSimangaliso Wetland Park, 1999; Vredefort Dome, 2005; uKhahlamba/Drakensberg Park, 2000; #Khomani Cultural Landscape, 2017, and Barberton Makhonjwa Mountains, 2018). Geoscientists had their work cut out during the periods from application to certification, and through continuing development.

Having been an ardent impact-cratering worker, I am most familiar with the Vredefort World Heritage saga. I ask myself whether I really want to write

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In the Barberton Mountainland southeast of Barberton town—part of the Barberton Makhonjwa World Heritage Area.

about this though... But as you guess correctly, I cannot shut up about it. First, let me congratulate the Three Musketeers from Potchefstroom—Martin Brink, Billy Bisschoff, and Frans Waanders—who in July 2005 managed to obtain a WHS listing for a fifth of the territory of the Vredefort Dome, the central uplift structure of the world´s largest-known impact structure. Wow, that was already 17 years ago! And what has happened in this considerable time? In a nutshell: the sense of place was changed early on when country roads were tarred, but the site is essentially without management, landowners´ associations and provincial and federal structures have been bickering all along, having been successful only in obstructing any constructive management and development. A beautiful and reasonably well-planned Visitors Center was built on a prominent koppie near the small town of Vredefort—instilling entirely unwarranted hopes in the local population that numerous tourists would bring fortune to the local economy. Until that fateful day when the ceiling of the entrance area caved in, cracks started to develop all around the building, and the evidence of shoddy construction became ubiquitous. How will this saga continue? Will UNESCO continue to grant extensions to this listing, forever? Are the local and provincial authorities going to be able to halt mis-development and finally fulfill their obligations to the communities?

I have indeed heard that there are indications that things might improve at Vredefort. Reports, albeit already dated to 2019, have seemingly indicated that government and landowners may have entered a new discourse. Well, this would have been 2–3 years ago… Also, a little museum in the town of Parys now holds a room that informs about some of the special aspects of this exceptional geological area—a creation through a much-appreciated private initiative by Alan Wiggil, Chris Hatton, and Richard Viljoen. But allow me one more question: What happened to the donations of numerous exhibits for the Visitors Centre that had been made by the participants in the 2008 Large Meteorite Impacts and Planetary Evolution IV conference held at SUNWA lodge on the Vredefort Dome?

Incidentally, in the same month of the Vredefort WHS declaration, July 2005, a natural history for the Vredefort Structure was published: *Meteorite Impact! The Danger from Space and South Africa´s Mega-Impact—The Vredefort Structure*.[5]

The abandoned Visitors Center at Vredefort.

Two editions of this multifaceted geological, archaeological, historical and botanical story were quickly exhausted, and then the third edition was published overseas. Hardcopy of that is sold out too, but the e-book continues to be marketed by Springer Publishers—unfortunately, at a price that is not friendly to the obvious main readership that is based in South Africa. Vredefort has continued to be a sought-after study object for geoscientific research and student education, but the recognition and tourism potential so widely expected from WHS status have not been achieved.

The geoconservationists in the GSSA would have been busy with their involvement in these national and international developments, with changing foci on geosites, geotourism, conservation issues, legal and managerial issues related to mining and heritage legislation, acceleration of tourism development in SA, concepts of ecotourism and geotourism gaining importance around the world, geoeducation at various school levels not to be forgotten… The more so it is necessary to hail the supporters inside and outside of the GSSA that kept the geoconservation flag high.

What else can I write about? This historical view has become long already…. Aaah yes, geovandalism was another concern that raised its (ugly) head repeatedly during the early 2000s, and will—in all likelihood—never quite go away (see a number of reports and a rebuttal of geoconservation in issues of *Geobulletin* of, *inter alia*, March 2004, April and June 2005). Allow me to state it again: For me, the need to pursue research is of paramount

Giant stromatolites in the Transvaal Supergroup, Mpumalanga.

importance—but it does not justify thoughtless destruction of nature.

While I took a lengthy sabbatical from South Africa in Germany as of 2005, and in Brazil since 2018, the activities of the GSSA Geoheritage Division have never floundered. Instead, annual events, symposia and sessions at conferences maintained the momentum. Finally, I managed to attend at least a part of the GSSA´s Geoheritage Symposium in April 2022. I found a hugely enriching programme with numerous facets encompassing aspects of the geological heritage of South Africa, new projects towards developing it for the public, for education, to link it with existing or new tourism facilities,

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Spectacular view across the impact-folded and faulted Hospital Hill quartzites of the western collar of the Vredefort Dome, looking north from Steenkampsberg.

museum or trail developments, programmes designed for schools, development of geo-projects in conservancies and private game reserves, and learnt about possible new geosites, the success of the Rock Garden at the Walter Sisulu Botanical Gardens, and the contrasting experiences from Virtual Reality versus Natural Evidence-driven projects. I was astonished to hear a request for a National Geoheritage Agency, and was kept wondering what the role of the South African Heritage Resource Agency (SAHRA) may have been over the years. Another aspect on which I reflected was how provincial administrations might have managed to develop Heritage Offices that could cater for protection of both the cultural and natural aspects of the country´s heritage.

Case studies were discussed in the symposium programme, and both advances and procrastination (Vredefort!) pointed out. What I, however, thoroughly missed were reports about successful interaction with government agencies. In fact, I missed the voices of national and provincial governments, and those statal and parastatal organisations that should be at the forefront of geoheritage and geoconservation efforts during much of the symposium. Who else but the Council for Geoscience and those Ministerial Departments charged with relevant responsibilities—Department of Environmental Affairs and Tourism (DEAT) and the Department of Mineral Resources and Energy (DMRE) —might have the resources to protect, conserve, develop for education, and eventually (hopefully) towards tourism?

The wish to apply our geological resources towards geotourism/ecotourism/tourism development pervaded the recent symposium. However, what has been achieved in the past 25–30 years in this regard? Are there any hugely successful geo-based establishments in the country that can boost a significant increase of visitors? Of tourists? If so, what exactly can be learnt from that? What is the advice to be taken away from such successes?

In the course of the concluding discussions at this symposium, the geopark card was played by quite a few participants. Indeed, some geoparks have been hugely successful in other countries. And there would be much to learn from these successes, be they in China, Europe, or elsewhere. I am also quite convinced that geoparks might have a future in South Africa, especially as I did hear the suggestion to try to link the geopark label with existing nature, game, biodiversity, and other types of reserves, or already-certified WHS, where managerial capacity could already be found. However, the first step must be to obtain the legal,

governmental framework to develop geoparks in this country. From the initial vetting of a geopark proposal, via national certification that already requires a sustainable management, to the ultimate goal—that is acceptance into the UNESCO Global Geoparks Network—governmental guidance and, yes, financial support will be required. Thus, if national government does not create a legal basis for a National Geopark Network such that a law determines how certification, management and development shall be conducted, international acceptance will not follow.

Also, those who hope that a geopark can rise from the ashes (of earlier tourism-oriented efforts) within a short period of time, should be aware that this would only be possible where the full might of a government is behind such a project. It has taken the Ries Crater Geopark in Germany, which has had the full support of the local municipal and district council structures, from 2006 to 2010 to become established in the German geopark list, and it took a further 12 years until its acceptance into the UNESCO Global Geopark Network (which was only achieved in April 2022). During all this time, from the inception of the plan to establishment of the natural, cultural, historical, and other aspects ('Ries Crater Culinary' programme) of this geopark, it has taken some 15 years. And do not forget that this geopark had already had, for years, a thriving Ries Crater Museum, with 25 000 to 30 000 annual visitors (not enough though to be self-sustainable). This and the other German geoparks are developed and operating against a backdrop of existing legislation for geoparks in Germany, a national organisation like the GeoUnion looking after the national network, and with the full backing of regional administrations (at county level, the so-called Landratsamt), and various municipal administrations. I am curious to learn whether the UNESCO certification of the Ries Geopark has already had any influence on this summer´s visitor numbers... However, what has definitely been achieved in this particular region of Southern Germany is identification of the local population with the particular geology and palaeontology of the region, and with the Geopark. Expert support over all these years has been provided to the Ries Crater Project by several panels of geoscientists, geographers, historians, archaeologists, palaeontologists, managers, and businessmen. These stalwarts by now must have held hundreds of meetings and site visits—entirely without receiving remuneration.

What is the current geopark situation in Africa? My rapid web research showed that just two sites—M´Goun in Morocco (valleys, natural curiosities, fossilised footprints, engravings and authentic Berber villages) and Ngorongoro-Lengai (an extraordinary volcano, extraordinary palaeoanthropological sites and extraordinary wildlife) in Tanzania—have so far been established in Africa by UNESCO. A third site—Baringo Great Rift Valley Geopark in Kenya—has been proposed, but its feasibility is apparently still under evaluation. There can be no doubt that South Africa has a large number of suitable geopark locations, and there are regional branches that could support proposals and provide guidance to non-specialists. However, it will be the latter, namely the administrators, managers, local landowners, and other interest groups, that—in each case—will have to be taken on board. They need to be convinced of the value of the resource and, realistically, about the possible economic and idealistic benefits.

I better stop here. I am aware that I may not be entirely knowledgeable of some matters that took place during my overseas residence. I am also aware that the one or other sentence may be perceived by some as high-minded or even overly negative. This is not the intention here. I was asked to write about my recollections, how it all started with geoconservation in the GSSA. And I want to use this piece to congratulate all of you who have carried the flag for promotion of geoheritage in South Africa, and who have been so successful with a large number of projects. Just two examples of these are the Barberton Makhonjwa Mountains World Heritage Site and efforts there by Tony Ferrar and colleagues, and the gigantic efforts that have

already gone into the Vredefort World Heritage Site project, from beginnings at Potchefstroom to the huge amount of time spent by Cristo Meyer and many friends, colleagues and sparring partners, to bring this project to fruition.

Congratulations to all of you geo-enthusiasts.

A note of appreciation

This perspective on the huge efforts of South Africa´s geoconservationists within and beyond the Geological Society of South Africa would be incomplete if the dedication and long-standing hard work in this field by one particular enthusiast would not be emphasised here: *Morris J. Viljoen, a stalwart of South African Geoconservation efforts*. Morris, who so untimely passed away a little over a year ago, on 19 August 2021, was a pioneer of the GSSA´s geoheritage and geoconservation activities. He tirelessly applied his enormous knowledge of South Africa´s geology and geological evolution to the promotion of the resource, the heritage, and the documentation of regional richness. He lived geology and worked in environmental geology. He had a multifaceted perspective—that of the geoscientist and the mining geologist and manager. His work around the Witwatersrand, along the eastern limb of the Bushveld Complex, and his, unfortunately due to his passing, unfinished geological record of the Kruger National Park, are mere highlights among his achievements from his decades-long efforts. I am personally grateful to have been able to work alongside of Morris for a few years, learning from him, benefitting from his phenomenal knowledge of South African geology, and admiring the great enthusiasm of this lover of nature, of geology, and of his country.

Acknowledgement

There are numerous others, inside and outside of the GSSA, who gave freely of their time and energy, helping with the establishment of a geoconservation community, promoting with books, talks, social media, and otherwise the fantastic natural geological landscape that this country offers. All these supporters of geoconservation, their vision, and their achievements, deserve our thanks and admiration. I am grateful to the Geological Society of South Africa for the invitation to present these recollections and thoughts.

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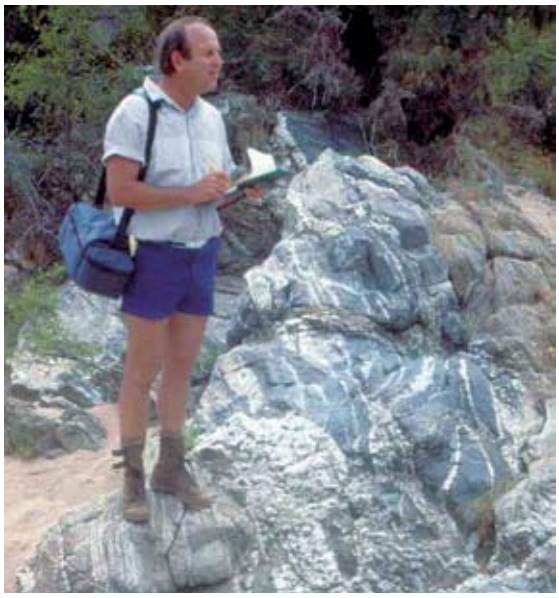
Morris Viljoen



Morris in typical field mode standing on ancient gneisses exposed in a river bed near the Pietersburg greenstone belt.

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geoheritage

Zinc-Lead Exploration and Mining in the Bergamasque Region of Northern Italy

Background

Where did the Romans get their zinc?

Although brass, a gold-coloured alloy of copper and zinc (called Aurichalcum in Latin), was well known before Roman times (the oldest brass objects known so far from Italy are two Etruscan finds preserved in the British Museum[1]), it was the Romans who placed it at the forefront of monetary policy and military power.[2] The location of Roman zinc ore mines has been notoriously difficult to trace, as slag, a typical indicator of metal production, is absent, and it has been generally accepted that the zinc came from mines in Germania.

One of the only written sources available from the Roman period is the Natural History of Pliny the Elder *(Book XXXIV, Chapter 2)*, who was born in the Bergamasque region of northern Italy, near Como. Pliny talks about cadmea mined in the region, which is synonymous with calamine, a historical term for secondary zinc ore consisting mainly of the minerals smithsonite, hemimorphite and hydrozincite.[2] The word calamine is no longer in general use today.

The beginnings of the use of brass by the Romans in the southern Alps dates from around 60 BC, and the first Roman brass coinage was minted around 45 BC by Julius Caesar, and it is thought that this minting of brass under Caesar began in Cisalpine Gaul at Milan.[3] If this is correct, the choice of northern Italy for the production of the first brass coins could be related to the city's close geographic proximity to zinc sources in the Bergamasque Alps. Tizzoni[1] was the first to suggest a connection between Roman zinc metallurgy in Milan and a potential zinc source in the Bergamasque Alps.

Merkel[2] proposes, through his archaeometallurgical analysis of ore and brass, that the Gorno ore district has the potential of being an important source of zinc ore, for example, for the production of 2nd Century brass sestertii minted in Rome. Although requiring further analysis, Merkel[2] proposes that his study provides a theoretical foundation for the interpretation of the lead isotope ratios of Roman brasses.

More recently, the underground zinc mine at Gorno was operated by the Italian Hydrodocarbon Authority, Ente Nazionale Idrocarburi (ENI), from 1888 until 1982, yielding reported mine production of 6 million tonnes grading at 14.5% Zn + Pb, which resulted in the production of high-quality 55–60% zinc sulphide concentrates.

Mining activities peaked during the 1970s, when many of the underground drives and areas of stoping that had been developed for zinc oxide ore were transitioning to sulphide ore mining, with underground drilling having delineated extensive zinc–lead mineralisation. A substantial tonnage of this undeveloped mineralisation was intended to be brought into production, but in the eighties ENI closed most of its base metal operations, including Gorno, to focus on its core business of hydrocarbon exploration and development.

From about 2015, Energia and now Altamin (ASX:AZI) have been conducting exploration and development activities, and in November 2021 completed a Scoping Study on the project. From this study, Altamin reported a total production target of 6.0 million tonnes from an Indicated and Inferred Resource of 7.79 Mt grading at 6.8% Zn and 1.8% Pb, containing 77% indicated and 23% inferred Mineral Resources at or above a cut-off

grade of 3.5% zinc equivalent at an annual mining rate of 800,000 tonnes over the proposed nine-year Life of Mine.[4]

On 25 July 2022, Altamin announced that Appian, a global specialist mining private equity fund with expertise in financing and development of mining projects, planned to invest up to US$65 million to earn up to a 67.4% interest in Gorno.[5] The project is currently undertaking a Feasibility Study.

Should this be successful, will we see the first hard-rock mine being developed in Italy in 40 years?

The Gorno Zinc Mining District

Deposits of zinc can be found spread from the eastern branch of Lake Como eastwards to Gorno in the Val Seriana. The Gorno district itself is a dense concentration of Triassic Mississippi-Valley-Type zinc-bearing mineralisation between the Val Brembana and Val Seriana, respectively, from the villages of Dossena in the west and Gorno in the east.

The Gorno district, encompassing the deposits of Dossena and Gorno, is the single major zinc ore source in the Bergamo region, and for that matter in continental Italy, and in the early 20th Century it was named among some of the largest zinc mining regions in the world, supplying both calamine and sulphide ore.[6]

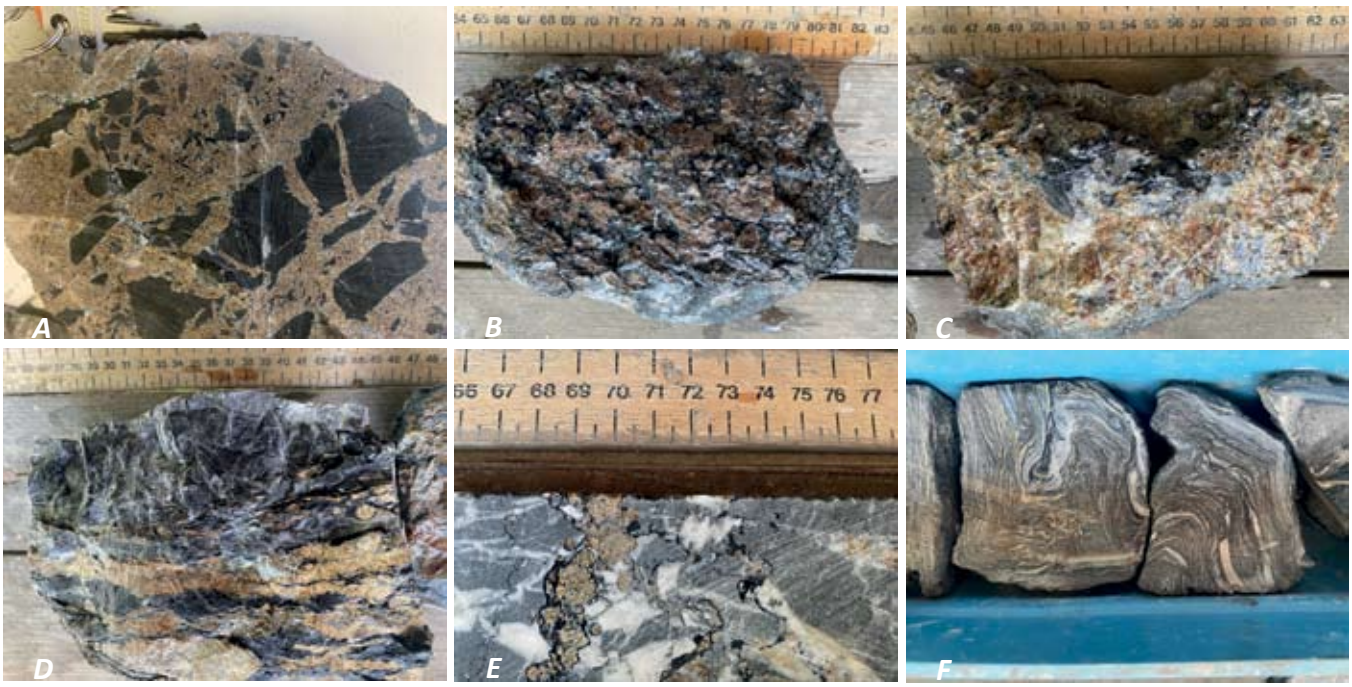
The Gorno Project is centred on the town of Oltre il Colle in semi-mountainous terrain with elevations ranging from 600 m to 2,500 m above sea level, with changes in elevation characterised by very steep slopes and incised river valleys. The area immediately above the Gorno deposit is dominated by the steep catchment area of the Val Vedra and Val Parina valleys.

The climate at Gorno is typical of the southern alpine region, with short, mild summers and long winters. The temperatures in summer have a mean of 17.3 °C and average monthly rainfall of 101 mm. The temperatures in winter have a mean of 2 °C with an average monthly snowfall equivalent to 115 mm of rainfall. The peak periods of precipitation occur in April—May and October—December.

Oltre il Colle itself is a picturesque village and is linked closely to the village of Zorzone to the north (under which is a part of the orebody) and Zambla Basso and Zambla Alto to the east. Only about a

The location of Oltre il Colle (arrowed) in the Bergamasque region of northern Italy.

View from Oltre il Colle looking eastwards towards Zambla Alto.



Mineralisation types at Gorno.
Part A shows sphalerite and galena in brecciated limestone;
B shows mineralisation in black shales;
C and D show mineralisation in Breno limestone;
and E and F show mineralisation in shear zones.

The area of historical underground workings and new exploration and development activities. The museum visited is at Riso.

third of the houses are occupied outside of holiday months and weekends, and the area is popular with hikers and skiers from urban areas. The area has seen significant post-WWII depopulation, and the permanent population of Oltre il Colle has halved since the 1950s.[7]

Geoheritage Museum

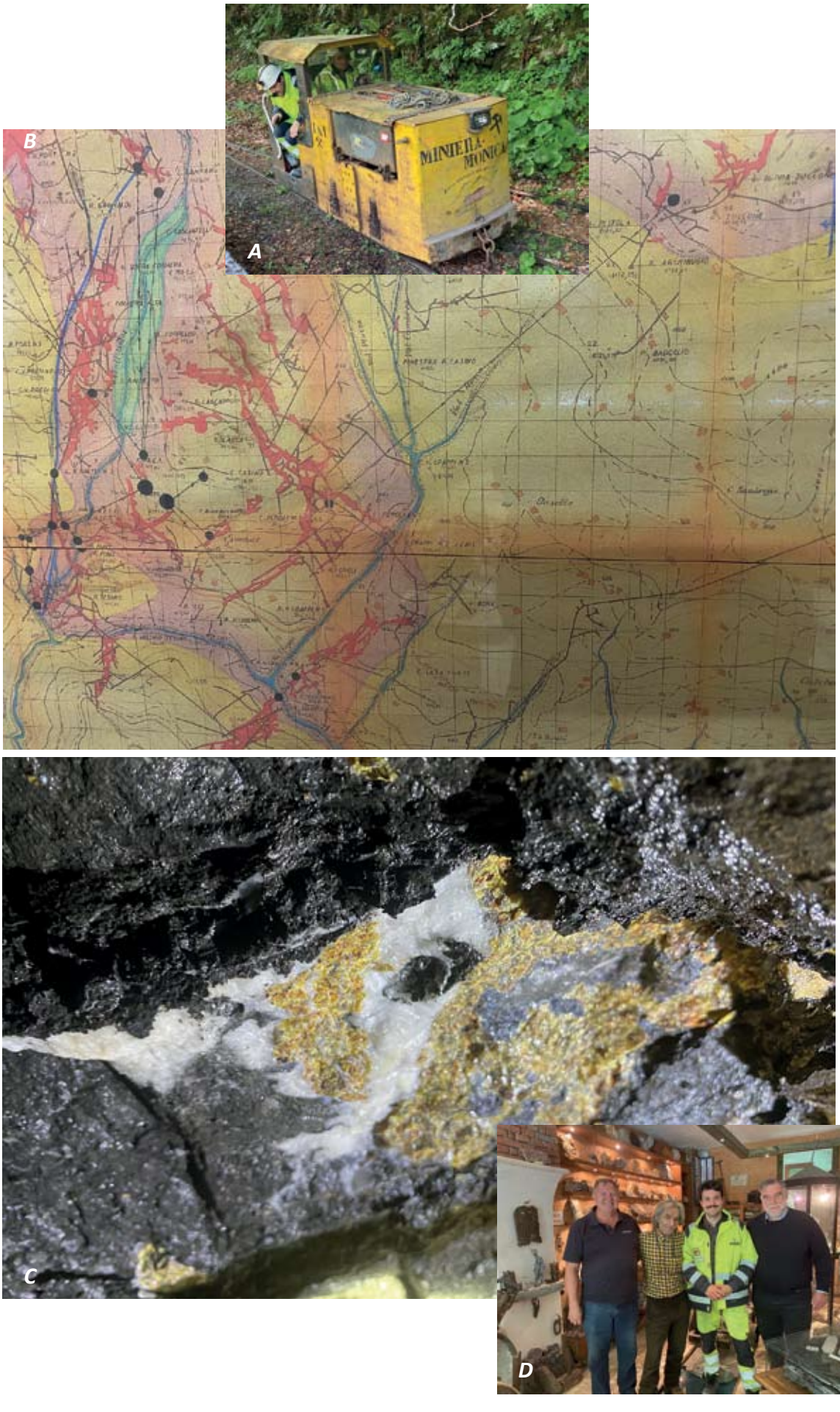
Historical underground workings, and some surface pits, extend along a strike some 8 km from Oltre il Colle to Riso, to the south-east. From Oltre il Colle, a winding road (called the SP46) with magnificent views takes you over the Zambla Pass and into the Riso Parina valley, which stretches to the main road (the SS671) connecting to Bergamo.

The Gorno ecomuseum is situated in Grassobbio, but was closed at the time of the visit. A secondary museum is situated at the opening of the Riso Parina tunnel, which connects underground workings over a distance of 8 km to Zorzone, adjacent to Oltre il Colle.

This Altamin-supported museum has a large selection of rock specimens, underground artefacts and historical maps, and one can arrange access underground.

Underground access was by small train to the Selvatici underground mining section. On the way we passed a small 560 kW turbine that was installed in 2007 and provides power for the region. The exposures of sphalerite and galena mineralisation in the host dolomites were magnificent, and reasonably fresh, considering that some of the excavations dated back 40 years or more.

The mining museum contains rock specimens from the region, including form the Gorno mines area, and mining artefacts such as a good selection of carbide lamps. There is even a section on fossils from the region. There are some magnificent specimens, although the labelling could be a bit clearer.



Scenes from the Riso Parina Mining Museum: A) the small engine used to transport visitors into the mine; B) an old mining map of the area; C) underground mineralisation; and D) the museum custodian, Severo Guerinoni, with Matt Mullins, Altamin geologist Niccolò Fiori and Altamin project manager Marco Milani.

The custodian, Severo Guerinoni, in the main section of the museum.

Conclusions

Are we about to see a revival of zinc mining in the Bergamasque Alps? The grades and tonnages are impressive, with significant upside tonnage potential. Although the proposed mining footprint will be almost exclusively underground and will provide some well-needed jobs in the area, there is understandably some nervousness on the environmental and social impact side.

The exploration and development activity is likely to see a revival in interest in the history of mining in the area, and further research into the archaeometallurgical sources of the zinc for Roman bronzes. As indicated by Pliny, Tizzoni[1] and Merkel,[2] there is a rich history of zinc mining that will be explored further.

In the meantime, if you happen to be in the area, the museum at Riso Parina is well worth a visit.

Matt Mullins

Head of Advisory – EMEAA Snowden Consultants

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Gorno Ecomuseum Contacts

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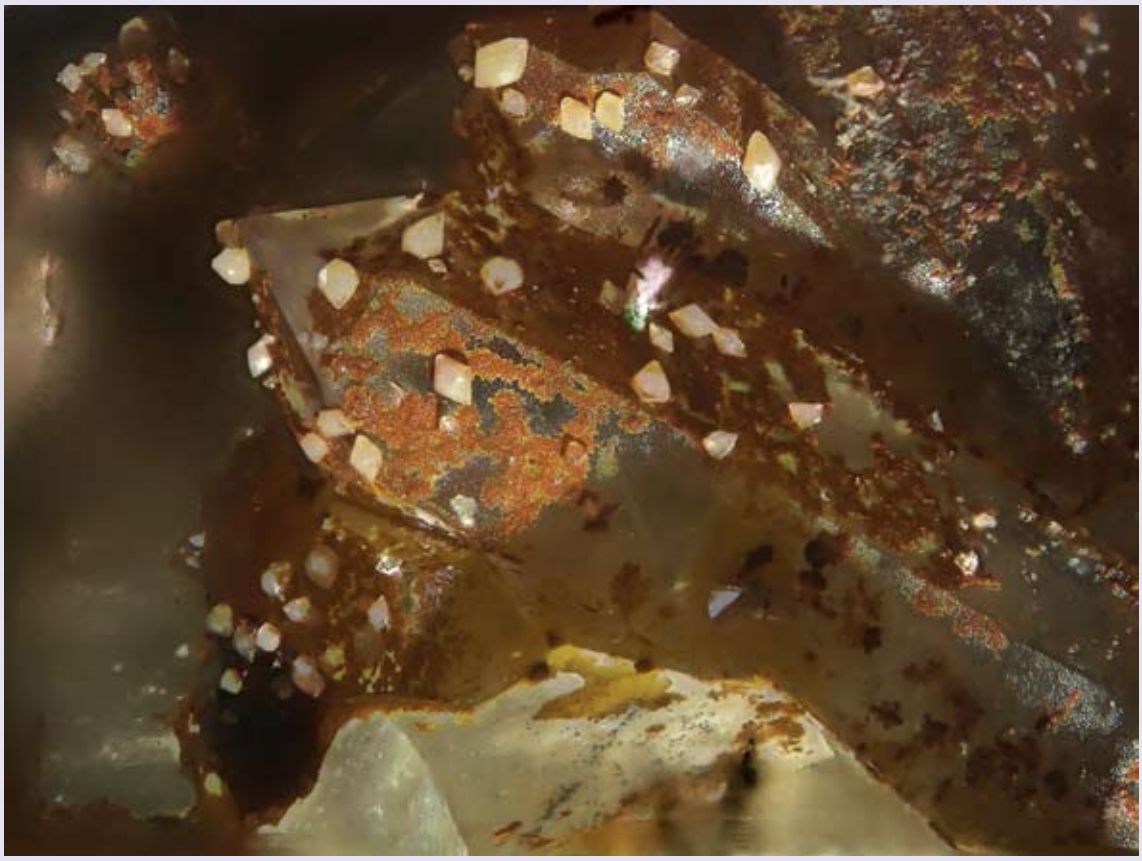
mineral scene

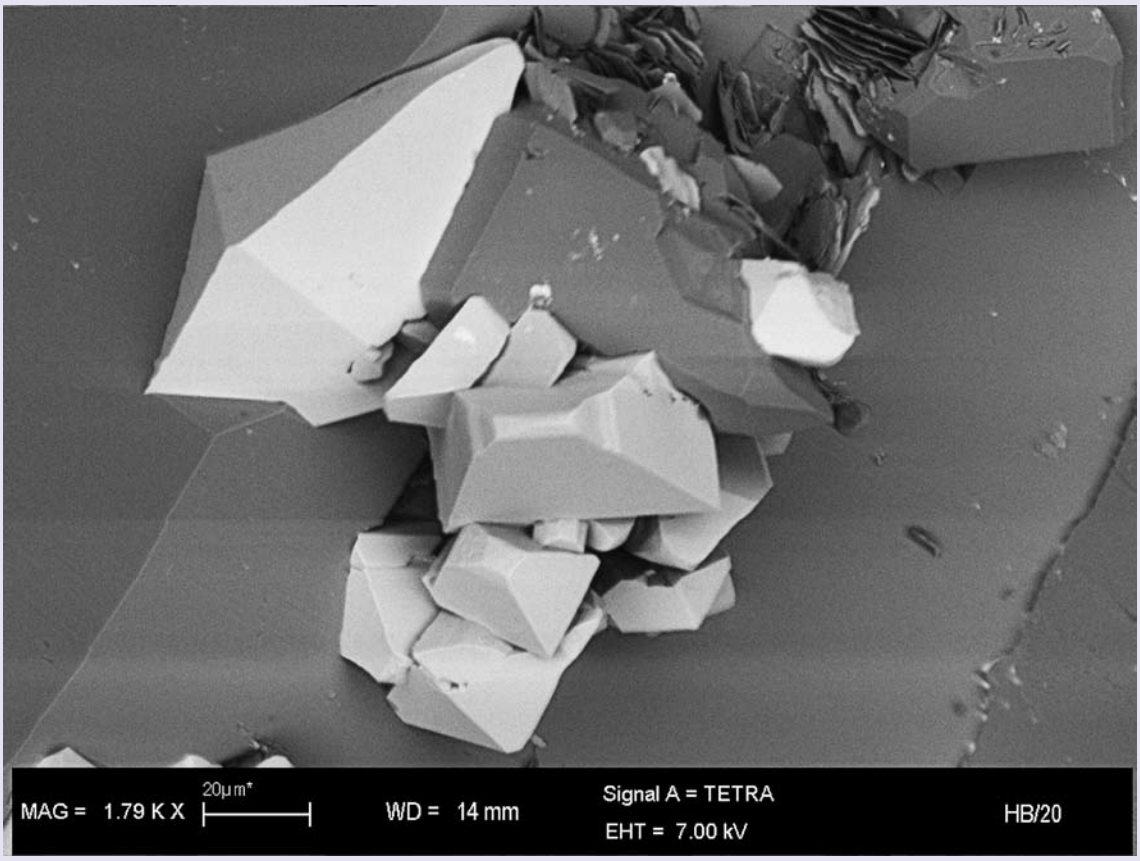
Anatase

This edition of the Mineral Scene delves partly into the realm of microminerals, although South Africa has produced some larger crystals, but these are extremely rare. The mineral in question is anatase (TiO_2). It crystallises in the tetragonal crystal system, commonly as dipyramids, has a hardness of 5.5 to 6, specific gravity of 3.79 to 3.97, a white to pale yellow streak, and an adamantine to metallic lustre. It has perfect cleavage. Anatase can be transparent to opaque and colour is varied, from brown, yellow, pale-green, blue to black. Rutile and brookite are also titanium oxide minerals and hence chemically identical to anatase but forming in different crystal systems. Anatase commonly forms as a secondary mineral, deriving titanium from other titanium-rich minerals, but does not need to be associated with such species. It occurs in alpine veins, granite and pegmatites.

Anatase is an uncommon mineral as large collectable crystals from southern Africa, but some localities produce beautiful small crystals. Tiny (1–2 mm) unusual (for anatase) white crystals exist in the molybdenite deposit at Houtenbeck in the Groblersdal district, South Africa. These occur in the Bushveld granophyre and are scattered on quartz crystals. Equally attractive dark-blue to black crystals less than 1 mm were once collected at Vaalkop Dam in the Rustenberg district. Tiny cavities in Bushveld Complex granite host the crystals. Associated species are cubic pyrite crystals and rhombohedral calcite, all as micro-crystals. What appears to be a once-off discovery of anatase on quartz was made at an undisclosed pegmatite / quartz vein close to the Orange River in the Northern Cape Province, South Africa. These crystals are also dark blue-black and associated with drusy, well-formed quartz crystals.

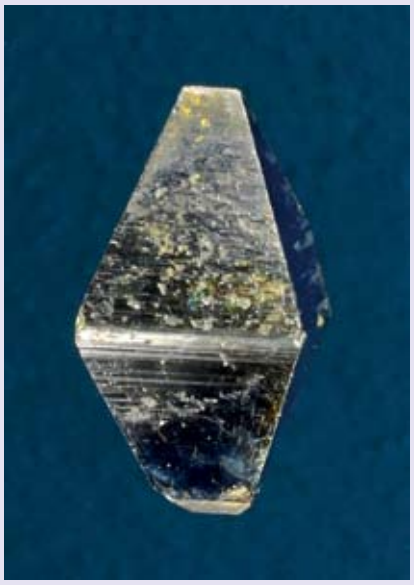


Minute white anatase crystals scattered about on goethite-coated quartz from Houtenbeck molybdenum mine, Limpopo Province, South Africa. The field of view is 10 mm. (Specimen and photo: Wolf Windisch)



Scanning electron microscope backscatter image of elongate anatase crystals from Houtenbeck molybdenum mine, South Africa. The field of view is 0.2 mm. (Specimen: Wolf Windisch; image: Maria Atanasova)

A 4 mm anatase crystal with tiny quartz crystals from the Orange River region, South Africa. The field of view is 2.2 cm. (Specimen and photo: Bruce Cairncross)



A 4 mm anatase crystal from the Orange River region, Northern Cape Province, South Africa. (Specimen and photo: Bruce Cairncross)

To date, the best anatase crystals known from South Africa were found in the Knysna district. These are associated with smoky quartz crystals and are hosted in Cape granite. The crystals are typically dipyramidal and up to 13 mm in size, making them the largest known from South Africa.

Equally small, usually less than 1 mm, anatase crystals are reported from a few localities in Namibia including the Erongo Mountain, the Gamsberg region, and the Giftkuppe rutile occurrence in the Omaruru district, where these occur together with rutile and albite.

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

A dipyramidal 1.3 cm anatase crystal with smoky quartz on granite from the Knysna district, South Africa. To date, this is the largest known crystal of anatase found in South Africa. (Specimen and photo: Bruce Cairncross)

obituary

Ian J. McKay †

Ian J. McKay
22 March 1963 to 13 July 2022

The doyen of palaeo- and geoscience outreach

Dr Ian McKay, born 22 March 1963, passed away on 13 July following a sudden heart attack. As a geologist's son, he developed a love of life sciences early in life and made this his career. Ian enrolled for a BSc at the University of the Witwatersrand, majoring in Zoology with sub-majors in Geology and Genetics. He completed a BSc Honours in Zoology at Wits with a major project on fossil insects from the Orapa Crater Lake deposits. Fascinated by the remarkably good preservation of these insects, it became a lifelong passion for discovering more about this ancient and important insect fauna. He went on to complete an MSc with distinction. This was upgraded to a PhD, which he completed in 1990, on carabid beetles and the palaeoenvironment of the Orapa deposit.

Ian subsequently worked for the Onderstepoort Veterinary Institute, undertaking research on ticks and discovering two new species. During this time, he realised that he had a calling for science communication and education, so he successfully enrolled for a Higher Diploma in Education at Wits. This led him to be appointed a science/environmental education specialist for the RADMASTE Centre associated with the University of the Witwatersrand. He led a programme in environmental education, writing science curriculum support materials, presenting courses on environmental education, and working on various special projects, one of which was to develop a low-cost kit for water quality testing.

Between 2001 and 2014 Ian managed geoscience/palaeoscience outreach in the School of Geoscience at Wits University. Here he was tasked to raise sufficient funding to undertake the work and to support his salary. Accordingly, he set up the company ITM Development Education Services, with the mission to facilitate development through out-of-the-box thinking, fundraising, conscientious project management, and the communication of technical information in plain language using entertaining and interactive techniques. He also enrolled for an MBA at Wits to sharpen his business skills. In 2014 he was appointed education and outreach officer by the newly established DSI-NRF Centre of Excellence in Palaeosciences. In this capacity, he operated nationally but was based at the Evolutionary Studies Institute at the University of the Witwatersrand.

While involved in Geo- and Palaeoscience outreach at Wits, he performed many functions, including school curriculum analysis and liaison with the Education Department and the DST (now DSI) for evolution and palaeontology to be introduced into the National South African school curriculum for Grades 10–12. To introduce this new topic, Ian was responsible for delivering workshops on evolution and palaeontology for subject advisors from eight of the nine South African provinces to assist teachers. He also designed educational programmes, museum exhibits, created hands-on biology and geoscience courses, trained student guides to present tours and designed holiday science programmes. This further

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involved the production of resource materials for teachers and learners, which were distributed to schools, as well as fundraising for the production of palaeontological exhibits. For several years he organised and ran National Science Week for the University of the Witwatersrand. This included fundraising, coordinating science communication, marketing and communication with the press, and coordinating various activities. Every year he participated in various science-related exhibitions such as Day of the Dinosaur Exhibition (Sandton Convention Centre), Yebo Gogga (at Wits), National Science Week (Sci-Bono Science Centre), Engineering Week (Sci-Bono Science Centre), Earth Sciences Week (Sci-Bono Science Centre) and Sustainable Energy Week (Sci-Bono Science Centre). He won several awards for his innovative exhibitions that were engaging and fun.

In addition to his engagement with learners and teachers at a national level, Ian was also an active member of the International Geoscience Educators Organisation (IGEO), oversaw the GeoSciEd conferences every four years, and the annual International Earth Sciences Olympiad. Ian served as the principal South African Councillor for IGEO. He was a founding member of the South African Geoscience Educators Association, responsible for organising and hosting the GeoSciEd VI conference at Wits in 2010. Ian was making plans to have the first-ever South African team enter the International Earth Sciences Olympiad. His fellow geoscience educators will never forget his passion, enthusiasm and dedication to geoscience education and outreach and his wonderful sense of humour.

In recent years, Ian ran a travelling exhibition called the "Maze of Time", which attracted huge crowds at the Grahamstown Science Festival, Rand Show and Wits Yebo Gogga exhibition. He established a partnership with the Life Sciences subject advisors of the Gauteng Department of Education, annually providing hands-on workshops and museum tours to support learning in the palaeosciences to thousands of school learners. Most recently, he spearheaded the development of an amazing poster set for various geoheritage sites from around the country.

Ian was instrumental in setting up and running (from Johannesburg) the Kitching Fossil Exploration Centre in the village of Nieu Bethesda. This is the only self-sustaining palaeotourism venture in South Africa and employs people from the local community as site guides. Visitors are given guided tours to the fossil-bearing rocks in the bed of the Gats River and fossil displays in the orientation centre. He was responsible for on-site guide training and raised funding to bring them to Wits University and the Cradle of Humankind for hands-on training and experience in palaeotourism activities.

Ian was a pioneer in large-scale palaeoscience outreach in South Africa. In later years, his hands-on and edutainment programmes reached more than 400 000 learners and members of the public annually. He delighted in explaining the palaeosciences to children, and they feasted on his presentations. In addition, to the outreach programmes organised and run by Ian, he also lectured on invertebrate palaeontology to honours students, undertook research and wrote papers, hosted postdoctoral fellows and supervised postgraduate students.

Ian had a quirky sense of humour, loved ice skating and outdoor activities, enjoyed bird watching and hiking and heavy metal music, and was fond of the highlands of the eastern Free State, particularly around Clarens, where his mother had a home. Ian gave considerable energy and dedication to geoscience and palaeoscience outreach, a task he undertook with passion and without seeking applause.

Ian was respected for his integrity and dedication to educating young people about the wonders of nature. Ian was a devoted father who is survived by his wife Tracey and his daughters Gwen and Erin, and stepdaughter Joy.

Bruce Rubidge *and* ***Gillian Drennan***

obituary

Ed Kable †

Ed Kable
1 August 1941 to 22 May 2022

It is with sadness that we inform members of the death of our friend, colleague and fellow geologist Ed Kable.

Edwin Jonathan Doveton Kable was born on Modderfontein "B" Gold Mine on 1 August 1941. His schooling was at one of the best South African institutions, King Edward VII School in Johannesburg. It was this stable childhood that contributed to both Ed's academic achievements and his legendary reliability. He was both a hostel and school prefect at King Edward. He matriculated in 1960 and attended the Witwatersrand Technical College, where he did the first-year geology course.

In 1961, Ed attended Witwatersrand University doing a BSc degree majoring in Chemistry and Geology. On completing his first degree, Ed moved to the University of Cape Town, where he did a BSc (Honours) degree in Geochemistry. In 1973, he completed his Doctor of Philosophy in Geochemistry on aspects of the geochemistry of selected elements in basalts and associated lavas.

Once he had graduated, he commenced work at MINTEK as a geochemist. He was seconded for a time to the Activation Analysis Research Group at the Schonland Research Centre at the University of the Witwatersrand. When MINTEK terminated geological research programmes in 1977, Ed joined the University of the Witwatersrand staff. In 1979, Ed joined the Chamber of Mines. A portion of his work involved conducting geochemical research projects on the rocks of the Witwatersrand Supergroup. His research included presenting a paper at the First International Congress on Applied Mineralogy in 1981. The paper comprised the initial results of a study into the minor and trace element geochemistry of pyrite pebbles in the Witwatersrand gold-bearing conglomerates. Much of the original unpublished data from this uncompleted study still exist and, as was typical of Ed, are stored in an organised and neat manner for potential future use.

Because of Ed's interest in nuclear technology, in 1985 he was appointed as chief scientist at the Atomic Energy Corporation in the Nuclear Technology and Industrial Services Division. Ed found that there was limited scope in nuclear applications and in 1988 moved to Gold Fields (South Africa) Mining and Development Division. With restructuring within Gold Fields, Ed was appointed Group Chemist at Gold Fields Laboratories. His responsibilities included many components of laboratory management and technological development. He was also involved in the implementation of procedures leading to accreditation of the Gold Fields laboratories.

When the SGS Group acquired the Gold Fields Laboratory in Southdale, Ed stayed on as one of the senior members of the SGS staff, and played

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a key role in developing the SGS business. Ed built a reputation for both technical excellence and integrity. His ability to listen made him immensely popular with SGS clients.

Dr Ed, as he was popularly known by most of his colleagues at Gold Fields, Lakefield Research and SGS Laboratories, was dedicated to the science of geology, geochemistry and analytical chemistry and used his natural curiosity to tackle problems in the organised, stepwise methodology that was typical of his approach.

To his fellow employees at SGS, Ed was much more than just another work colleague. He was a loyal friend of every staff member he engaged with. His office door was always open to anyone at any level to walk in and share any issues/problems that they had. His ability to blend, communicate and engage with staff at all levels and all ages was just an amazing natural characteristic that he possessed. He had a hand in the careers of many of the younger staff members, providing support, mentoring, guidance, and motivation accompanied by a positive outlook. Ed's word was his bond, and he was trusted implicitly by colleagues, peers, and clients alike. He was an extremely strong role model for future generations and was a mentor to many.

Ed loved life, his special wife Sonja, and her extended family, and he loved Airedale Terriers and Range Rovers. Ed was a gentleman's gentleman who always dressed impeccably. He tolerated golf for Sonja but would rather be pouring over the latest journal of geochemistry or analytical chemistry than "hitting that silly white ball." He was a proudly South African through and through who always marvelled at the progression in post-Apartheid South African society, but also worried if South Africa's governments structures were strong enough to withstand the pressures that they were facing. He will be deeply missed by all who had the privilege of knowing him and especially by those who worked with him.

A true gentleman and friend in every sense of the word.

*Compiled and written by **Keith Kenyon**, with contributions by **Russ Calow** and **Dereck Govender** of SGS.*

obituary

William J. de Klerk †

Billy de Klerk at Addo Elephant National Park with his display on the Kirkwood Formation. His life-sized model of Nqwebasaurus thwazi, an early ornithomimosaurian theropod dinosaur discovered by him, fills the foreground. Photo ca. 2011.

William J. de Klerk
2 September 1952 to 9 July 2022

It is with great sadness that we announce the peaceful passing of Dr William J. de Klerk on Saturday, July 9th, after a short illness. Known to all simply as "Billy," he was a relentlessly upbeat colleague with a buoyant personality and a deep love of Africa.

Billy was born in Johannesburg on 2 September 1952 and matriculated from Potchefstroom Boys High, where he built many boyhood friendships that became life-long. His huge circle of friends

was an asset he greatly prized. He enrolled at Rhodes University for a BSc degree in Geology, but this expanded into an MSc and ultimately a part-time PhD on the Bushveld under the supervision of Hugh Eales. While at Rhodes, he met Vivian Cole—they were later married and remained totally devoted to each other. Billy initially worked as an exploration geologist for FalconBridge in Namibia, before embarking on a short career in the platinum industry in Swartklip and Rustenburg, ending up with the Atomic Energy Corporation at Pelindaba, where has was based in Krugersdorp. At the time, Viv had a part-time teaching position at the Krugersdorp Hoërskool, but was lured into academia at Rhodes and Billy was appointed to the staff of the Albany Museum as Curator of Natural History Collections in 1986. At that time, computerisation of museum natural history collection catalogues was the subject of debate at every SAMA conference, but little was being done. Billy took the bull by the horns and used the dBASE-compatible and inexpensive database program PC File to digitise the Albany Museum collections. As a result, he was asked to give courses to curators at different museums in the country and this set the stage for the well-organised state of the Karoo fossil stores nationwide.

Although trained as a geologist, at the Albany Museum Billy was able to indulge his life-long passion for fossils. Eventually the position of Curator of the Earth Sciences Department was established at the museum, and happily Billy was appointed to the position, which he enthusiastically occupied for three decades. In this capacity he built the fossil collections of the museum by initially exploring the relatively unresearched Jurassic and Cretaceous deposits of the Sundays River and Kirkwood formations of the Algoa Basin. This work was initially undertaken by himself, but the programme expanded to include numerous local and international collaborators, many of whom continued to work with him well into his retirement. This team discovered several new dinosaur species and opened a new avenue of palaeontological research in South Africa. Because of his keen eye for spotting fossils, Billy later expanded his horizons to include the Karoo. From the Beaufort Group, he described a remarkable palaeosurface bearing the footprints of seven individuals of the large dicynodont *Aulacephalodon* walking across the floodplain. This provided new evidence on the morphology of the genus and also social and herding behaviour of dicynodonts, the dominant herbivores of the Permian period. His collecting prowess included the dinosaur-bearing beds of the Stormberg and his discoveries of well-preserved dinosaur specimens have resulted in several important papers.

Billy lectured Palaeontology to undergraduate students at Rhodes University for more than two decades, overseeing many Honours projects (including that of his son, Andrew, also nicknamed “Billy” by his university peers). He was renowned for his field trips, which were widely regarded as “edutainment”, and which visited key palaeoheritage sites such as the Kirkwood cliffs, Addo Elephant National Park, and of course, the Karoo. He published more than 20 peer-reviewed scientific papers, which have been cited nearly 1000 times. Chief among these contributions was his work on the Kirkwood Formation, including the discovery of *Nqwebasaurus thwazi*, the first dinosaur to bear an isiXhosa name.

Billy made major contributions to the public understanding of palaeontology through museums and outreach. He had superb manual preparation ability (evidenced by the turned wooden bowls and pepper grinders gracing many of our dinner tables), and used it to make beautiful display items out of the specimens he collected. As the Earth Sciences Department at the Albany Museum grew under his headship, he taught and transferred his preparation skill to newly appointed fossil preparators in his department. Billy’s revamped palaeontological displays at the Albany Museum, with artwork by Gerhard Marx, continue to draw visitors and school groups, and graphics from these displays have been widely used in local and international publications. He has been a pioneer

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Billy putting the finishing touches onto his reconstruction of the gorgonopsian Rubidgea for the palaeontology exhibit at the Albany Museum.

in building life-sized reconstructions of South African prehistoric animals for the Albany Museum displays and these models have subsequently also been bought by other museums in South Africa. His exhibition on the Kirkwood Formation at Addo Elephant National Park is seen by 160,000 people per year. Billy was instrumental in setting up the country's first sustainable fossil palaeotourism project in the Karoo, at Nieu Bethesda, and he remained involved in this venture until his death. He also served the disciplines of museology and science through active participation on several committees. For these contributions, Billy was awarded a lifetime membership by the Palaeontological Society of Southern Africa in 2016, the highest award of that society.

We remember Billy for his balanced humanitarian view of life, his indomitable enthusiasm and great sense of duty to the palaeosciences and fellow humans. He energised any fossil expedition he joined, and made visiting the Albany Museum a wonderful experience for many years. Outside of palaeontology, he was an expert wood-turner, a keen birder and conservationist, a veritable master sommelier of South African vintages, and a diehard fan of good old rock n' roll. He was loved by children and young people, as he always had an unexpected and exciting trick up his sleeve. He treasured his family, was a wonderful father and grandfather, and together he and Viv established a generous and welcoming home in Makhanda.

Billy is survived by his wife Viv, his children Jenny, Andrew, and Chris, and grandchildren William, Erin, Richard and Michael. He lived a very full life; he and Viv travelled extensively, both locally and internationally, where they always made time to call on their large circle of friends.

Jonah Choiniere**, **Bruce Rubidge** and **Andrew de Klerk

GSSA awards

The Fellows Committee of the GSSA adjudicates Student and Professional awards on an annual basis; the proposed winners are then ratified by Council. This year the award winners for 2021 were announced at the Annual General Meeting on 14 July. The Student Awards were presented at the AGM; the professional awards will be presented at the Fellows Dinner in November. The GSSA congratulates the winners.

The award criteria can be found in the by-laws of the GSSA, lodged on the website. The Student Awards comprise the John Handley Award for the best MSc thesis, the Haughton Award for the best Honours thesis, and the SACNASP award for the best overall 4th year student. The nominations are submitted by Department Heads and the supervisors, and the standard of the nominations is invariably very high.

The Professional Awards include the Draper Medal life-time career contributions to the earth sciences, the Des Pretorius Award for contributions to economic geology, and the Jubilee Medal for publication of the best paper in the *South African Journal of Geology* in the year preceding.

The John Handley Award was given to **Ryan Rosenfels**, Stellenbosch University, for a thesis entitled 'Characterising the Fungurume 88 Deposit in the Tenke Fungurume Mining District: An unusual, high grade, primary cobalt sulphide deposit' supervised by Bjorn von der Heyden.

The Haughton Award was won by **Rutger La Cock**, Stellenbosch University, for a thesis entitled 'Manganese deposits within the Cape Supergroup and their relation to thermal springs'. This work was also supervised by Bjorn von der Heyden.

The SACNASP award went to **David Russo**, Wits University. His thesis is entitled 'The nature and origin of carbon nodules in Precambrian granite/gneiss terrains with specific reference to the Konsberg Region in Norway' and was supervised by Gillian Drennan.

The Draper Medal is the highest scientific award of the GSSA, and is normally awarded to a single person. This year, a dual award was proposed and accepted by the Fellows Committee and Council (there is precedent). The award goes jointly to **Judith Kinnaird and Paul Nex** for their contributions in a number of initiatives during their career at Wits. Note that both of them serve on the Fellows Committee, but recused themselves from the adjudication process.

The Des Pretorius Award goes to **RE (Jock) Harmer** for his contributions to economic geology in the private and public sectors. Jock is perhaps best known for his work on REE mineralisation, particularly in carbonatites and related alkaline rocks.

The Jubilee Award went to SE Scheiber-Enslin, M Manzi and SJ Webb (2021), Seismic Imaging of Dolerite Sills and Volcanic Vents in the Central Karoo, South Africa: Implications for Shale Gas Potential, *South African Journal of Geology*, Vol 124 (2), 465–480. The paper demonstrates that shale gas potential in the Karoo basin is complicated by the dolerite distribution. This may not have been considered in the first targeting exercises carried out a few years ago.

Craig Smith

GSSA events 2023

GSSA Events from January 2023 to November 2023 (Preliminary Programme)

DATE	EVENT
11–13 January	Geocongress (Stellenbosch University/Hybrid)
7–28 Feb (4 x ½ days) + self-study	Drilling Methods & Techniques in Resource Exploration (online)
14 March	CPD Workshop (online)
2–3 May	Sampling & Data Management
May	KZN Brittle Deformation Fieldtrip (KZN Northcoast)
June	Soft Skills for Geoscientists
24–27 June	Base Metals (hybrid & site visit)
July	Map Making with MINROM (Contact in CT)
11 July	ESG Inquisition Feedback (online)
1 August	Introduction to Drilling (online)
Sept (2 days?)	Data Analytics / Machine learning (Hybrid?)
September (4 x ½ days) + self-study	Drilling Methods & Techniques in Resource Exploration (online)
October	3D Geological Modelling
October	Mineral Economics for Geoscientists
15–16 November	African Exploration Showcase

Field Excursion to commemorate the Centenary of the discovery of PLATINUM in the Eastern Limb

Key Dates & Accommodation:

Thursday 15 to Sunday 18 August 2024
Gethlane Lodge, Burgersfort

The discovery of economic platinum mineralization by Hans Merensky and his Lydenburg Platinum Syndicate at Mooihoek, on 15th August 1924, is one of the most significant geological and mining events in South Africa. This initiated a "Platinum Rush" which led to discovery of three additional mineralized pipes and the Merensky Reef.

The field excursion will include the following sites (dependent on permissions from mining companies):

- Famous geosites: Dunite Pipes (Driekop Mooihoek, Onverwacht); Merensky Reef, UG1 and UG2 chromitites; Discordant IRUPs
- Underground visit to historical workings on the Merensky Reef at Winnaarshoek
- Cultural sites: Botshabelo Mission (Hans Merensky' place of birth, in 1871); Battle of Sekhukhune; Tsjate Cultural Centre

Contact Dr R N SCOON or the GSSA for details and an expression of interest. (rnscoon@iafrica.com)

Hans Merensky (1917)

Hans Merensky (3rd from right) and his team panning for platinum at Onverwacht (Photograph from Lehmann, 1955)

The glory hole at Onverwacht, the world's oldest hard rock platinum mine

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GSSA membership

The GSSA has lost track of the following members, and would like to re-establish contact. In many cases it is likely that email addresses and/or phone numbers have changed and the GSSA has not been made aware of this. If our members have contact details for any of these members, please let us know at info@gssa.org.za.

Alo, Mr Godwin Amobi
Boshomane, Ms Mpho
Clarke, Mr Brendan Morgan
Diale, Mr Tumelo Kamogelo
Ditlopo, Ms Lydia L
Gaegopolwe, Mr Pitso
Gopolang, Mr Innocent
Gumede, Ms Amanda
Gumindoga, Mr Howard
Hlongwa, Mr Hloniphani
Hulisani, Mr Manenzhe
Katz, Ms Rosemary
Kgaile, Mr Oduetse Moswang
Kitt, Mr S
Legoale, Ms Tshiamo
Lemekoana, Ms ML
Leshabane, Mpusheng
Letsie, Ms PE
Lukhele, Ms Belinah
Maipushi, Ms Sophy Mmatsele
Maluleke, Ms Lizah
Mandiwana, Mr Rendani
Mashavha, Mr AL
Mashigo, Ms Nqobile
Mashishi, Ms Elizabeth
Matamela, Mr Phathutshedzo
Mdanda, Ms ZN
Mdze, Mr Manelisi
Mhlanga, Mr Solani
Mokgothu, Mr Kagisho
Mokonyama, Ms Adelaide
Molefi, Mr Kgalalelo
Mosala, Mr Tshegofatso Clifford
Mosamedi, Mr Winas
Motene, Ms Karabo
Motsoeneng, Mr Tsokolo Phillip
Munyawiri, Mr DT
Munzhelele, Mr Thabelo Joshua
Muofhe, Ms Tovhowani
Ndlela, Mr Ntuthuko
Netshilindi, Mr Gregory
Ngwanza, Mr Patient Yumb
Nxumalo, Mr NN
Pather, Mr A
Phala, Ms Omphile
Phato, Ms Nikiwe
Ramusi, Ms Matlala
Razwimisani, Mr Thendo

Samuel, Mr Matlhogonolo
Sandani, Mr Humbulani
Sebetlela, Ms Teboho
Sekai, Mr Mpho Donald
Shisana, Mr Masingita
Tembo, Mrs Qedile
Tshivhandekano, Mr Nkhetheni

GSSA
Geological Society **of South Africa**

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excl VAT

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

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

6. CANCELLATIONS

At least 4 weeks prior to deadline

7. CIRCULATION

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

8. ADVERTISING BOOKINGS AND SUBMISSION

Contact person: GSSA
e-mail: **lully.govender@gssa.org.za**
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9. ADDITIONAL CONTACT INFORMATION

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2022


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